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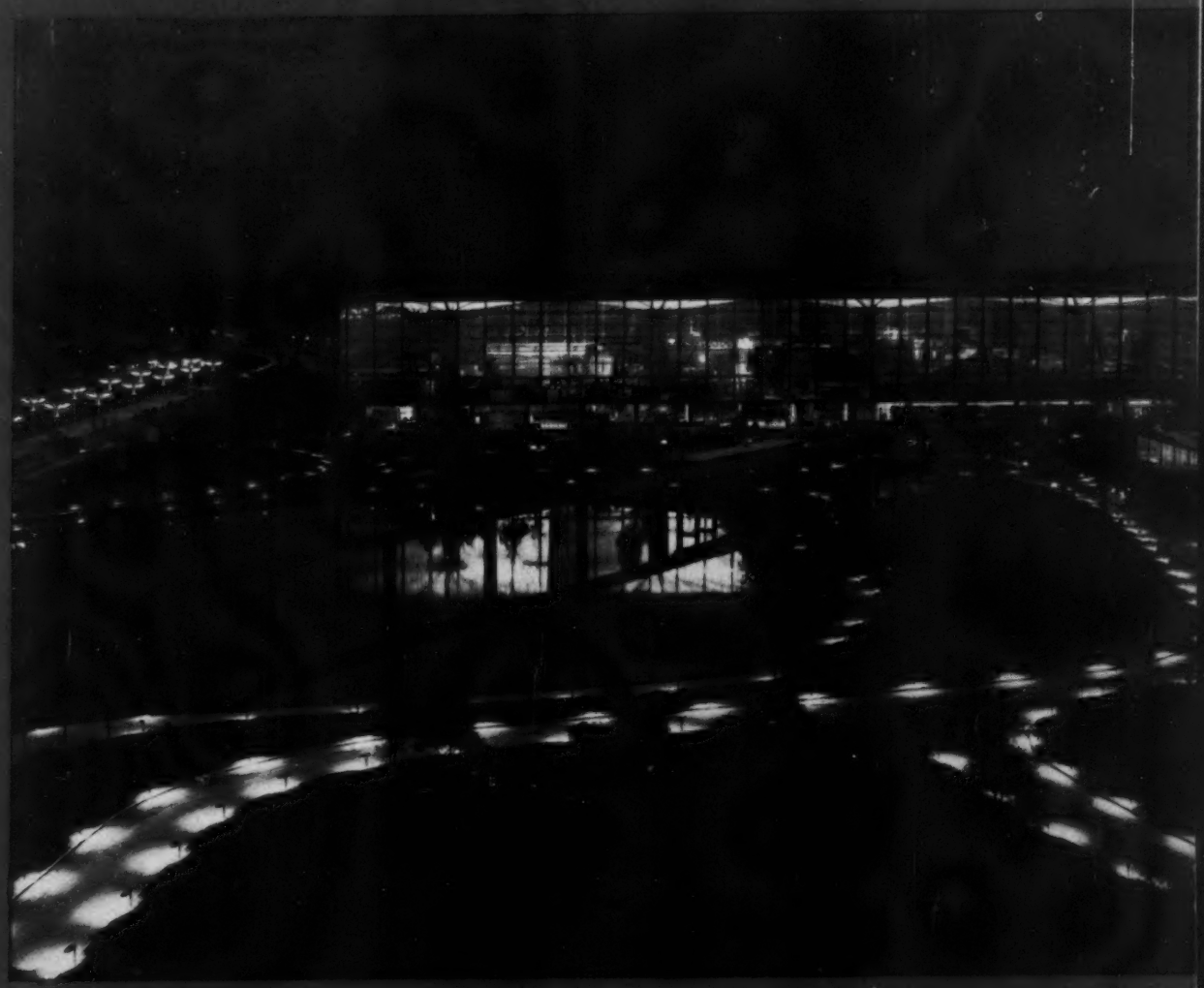
Light and Lighting

September 1961



The Palazzo del Lavoro at the Italia 61 Exhibition, in celebration of Italy's centenary as a modern state; impressions of this event, and of its lighting, are given in this issue.

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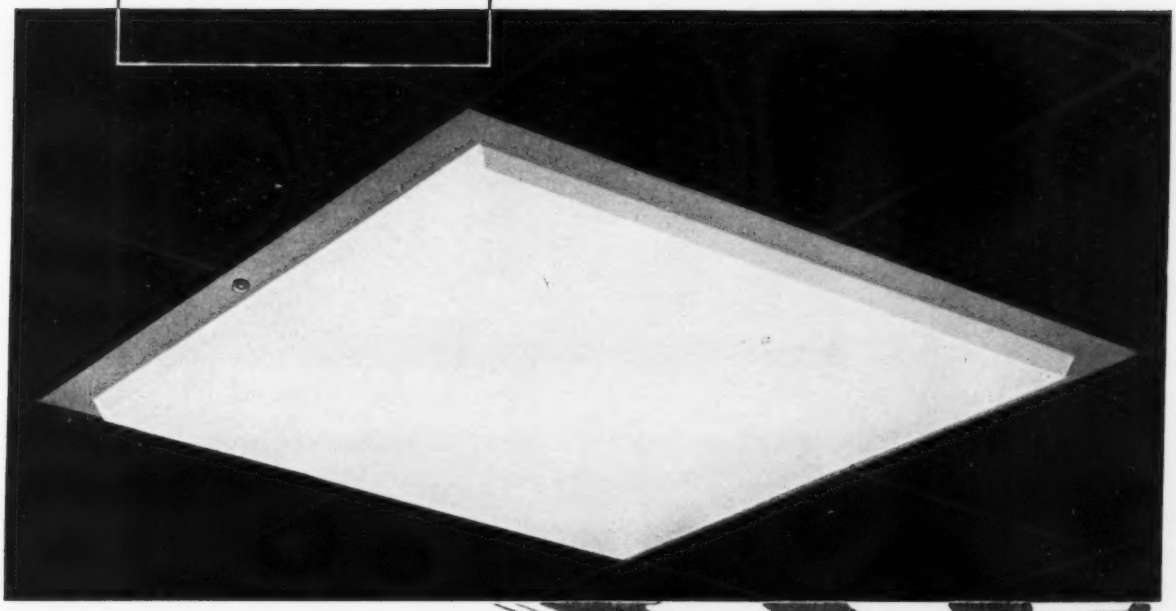

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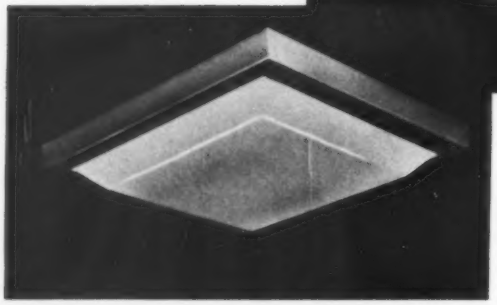

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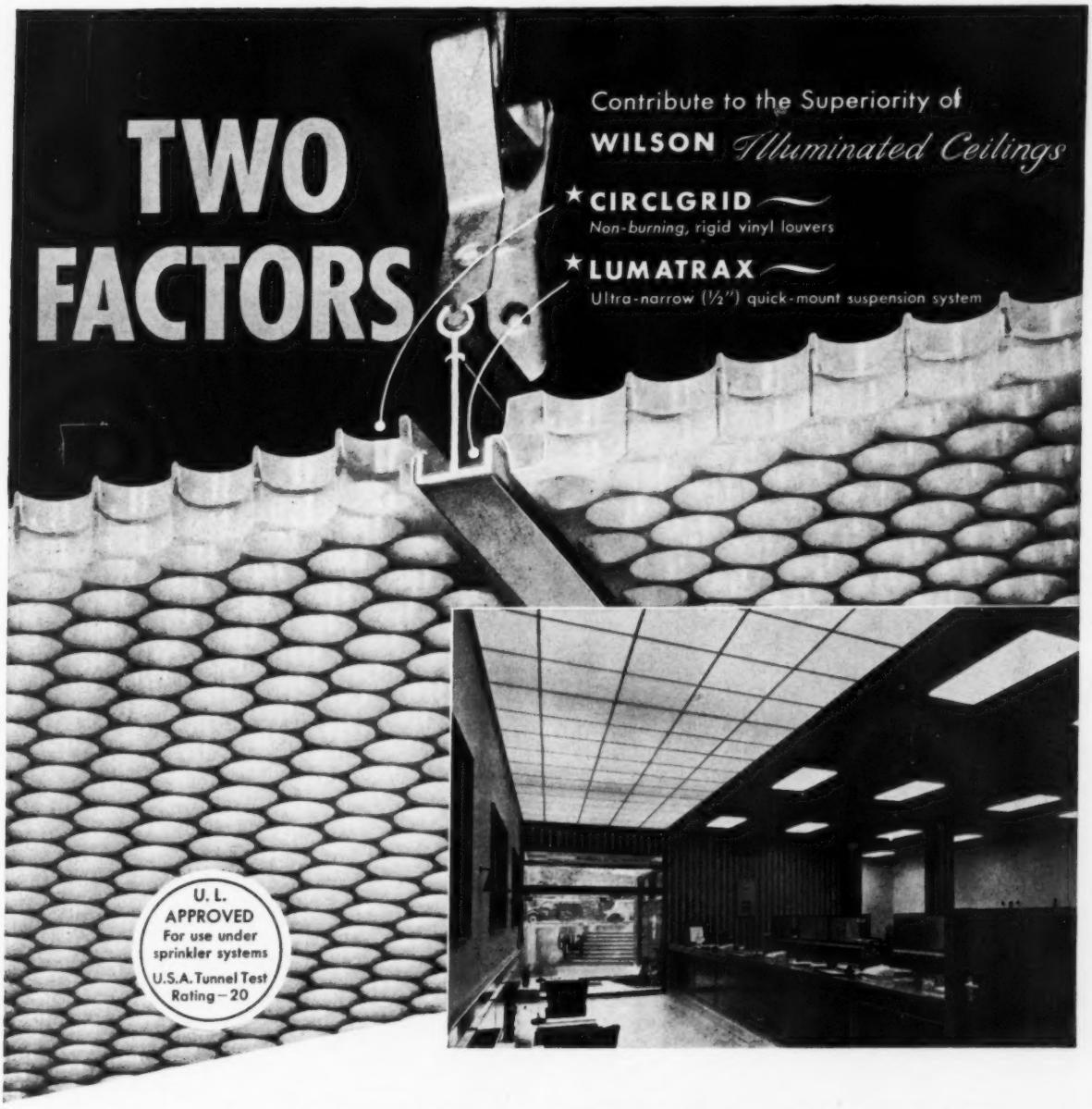

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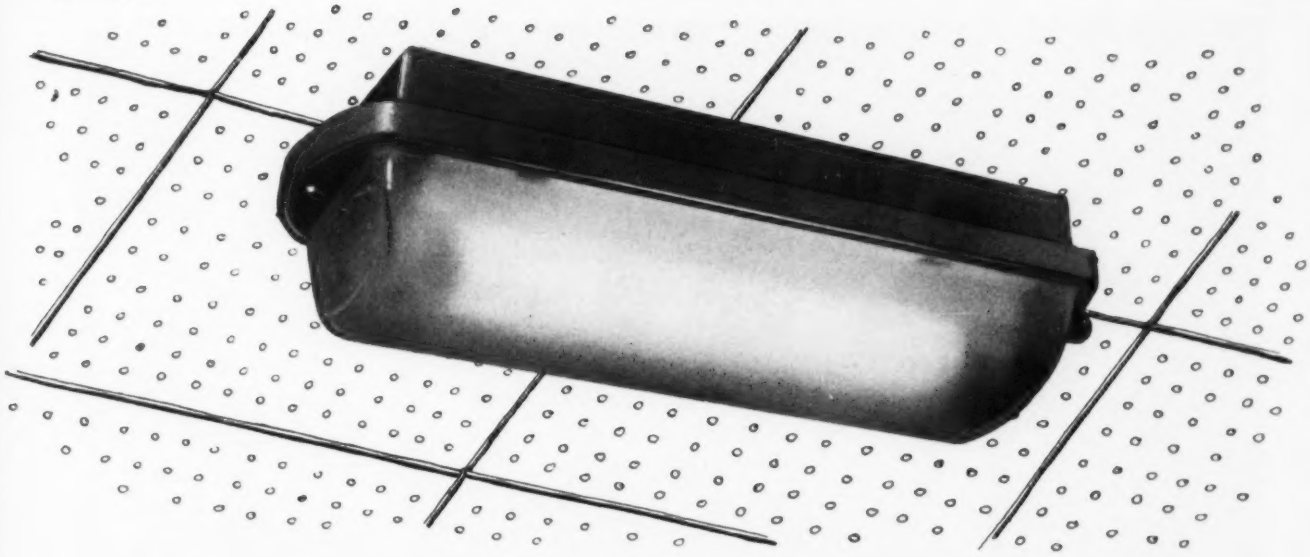

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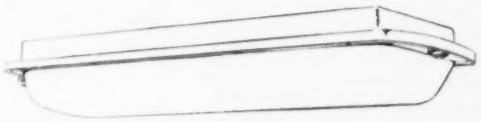
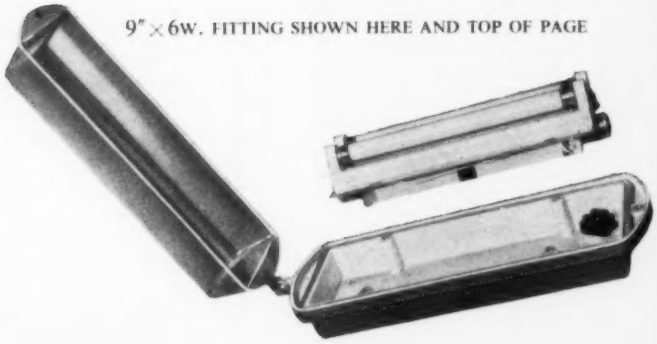


24" × 20W. FITTING



9" × 6W. FITTING SHOWN HERE AND TOP OF PAGE

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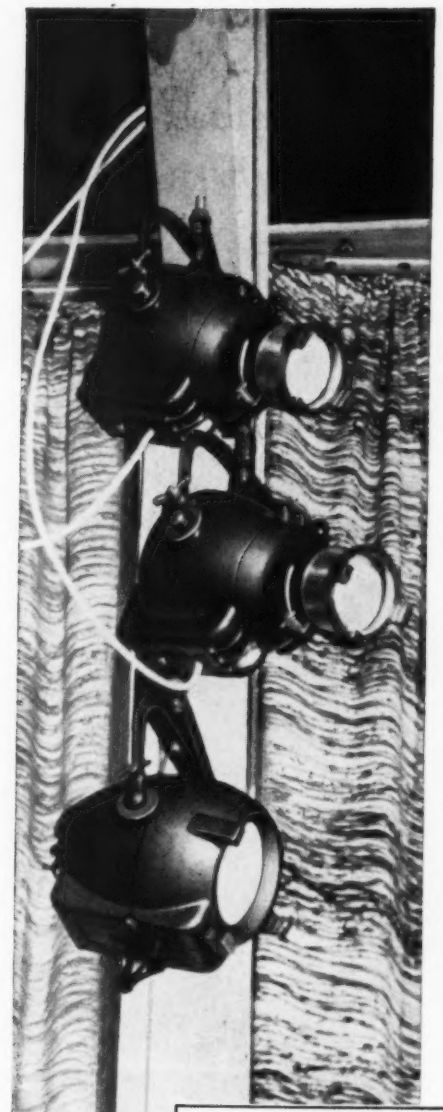
LIGHT AND LIGHTING



LIGHTING FOR ENTERTAINMENT

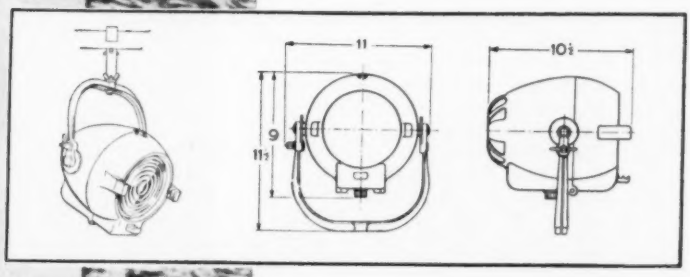
Ideally this type of lighting should be built in. Often this is not practicable. For example, rostrums in town halls or temporary stages in public assembly halls can often be effectively lit only from lanterns in full view of the audience.

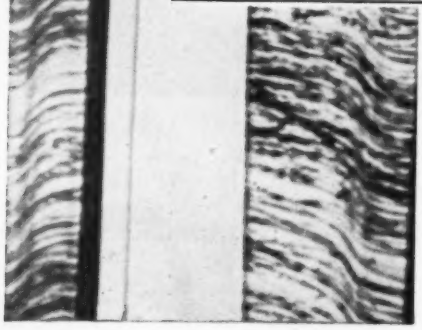
In such cases the Strand Baby Spot, illustrated here, provides the only really satisfactory answer. It is a neatly styled, compact lantern quite unobtrusive and capable of a higher light output than many much bulkier lanterns.

Strand engineers offer free advice on planning all such specialised lighting and a fully equipped contracts and wiring department to carry out the installation. You will almost certainly find it useful to have our new catalogue of lighting control equipment and lanterns by you. It includes all optical and mechanical data and prices from which specifications and estimates can be prepared. May we send you a copy ? and if you have not already received one, copies of 'Stage Planning 1961' are also available.

Strand Patt. 123 and 23 Baby Spots are neatly styled and of small dimensions so that concealment is often unnecessary.

The above illustration shows a Strand all-electric Saturable Reactor Remote Dimmer Control in use at Adelaide University. This control requires little maintenance and being extremely compact is ideal for small lighting installations up to 54 ways. This type of dimmer accounts for 5,000 of the 16,000 remote controlled Strand dimmers in use.





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Installations that suit the scene

Lighting installation in Roding Lane, Wanstead. Photographs by kind permission of L. S. Jeffery, Esq., A.M.I.C.E., M.I.Mun.E., A.M.I.Struct.E., Engineer & Surveyor of the Wanstead and Woodford Borough Council.

Today, street lighting has two equally important functions; the illumination level must be high and the distribution correct; the installations must harmonise with their surroundings. The equipment shown here does both jobs admirably. The HW.820 Elecoslim columns and Eleco Silver Ray Lanterns combine technical efficiency with modern, unobtrusive styling. The high standard of lighting provided by Philips MBF/U 250-watt lamps ensure maximum safety. The result is yet another successful street lighting scheme carried out by Eleco and Philips—one of many installed all over the country.

ELECO

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(85)

Illumination that's made for safety

The excellent illumination given by these Philips MBF/U 250-watt lamps ensures maximum safety for all road users. They provide excellent visibility . . . reduce the risk of accident. The efficiency of this lighting is matched by the efficiency and modern styling of the Eleco Silver Ray Lanterns in which they are housed, and the HW.820 Elecoslim columns that support them. This is just one more of the many successful street lighting schemes carried out by these two famous companies—Philips and Eleco. Their long experience is available to you at any time.

Lighting installation in Roding Lane, Wanstead. Photographs by kind permission of L. S. Jeffery, Esq., A.M.I.C.E., M.I.Mun.E., A.M.I.Struct.E., Engineer & Surveyor of the Wanstead and Woodford Borough Council.

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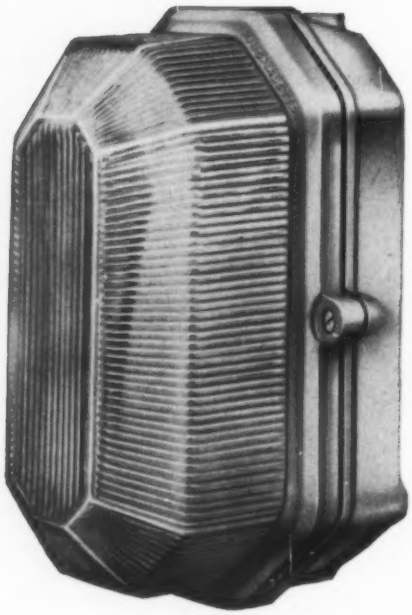

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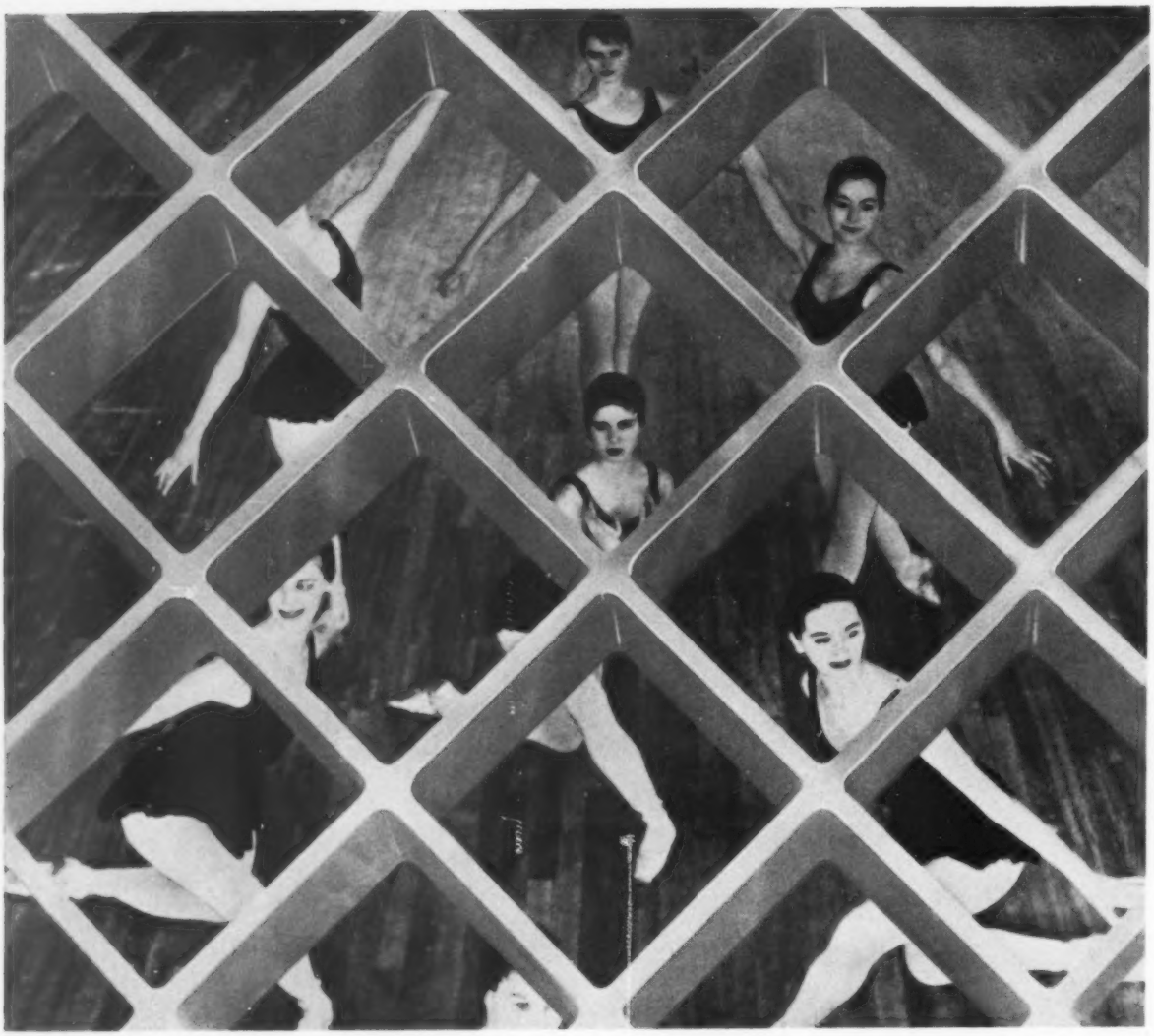

Light fantastic

Light on her feet, light above her head. There was a time when ballet was danced by candlelight – but a long time ago. Long before Shell gave us 'Carinex' light-stabilised polystyrene.
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Light and Lighting

Vol. 54 No. 9

Editor: G. F. COLE

Assistant Editor: D. B. WILLSON

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Technical Report No. 2

The publication of IES Technical Report No. 2 is an event of importance second only to the new IES Code itself. It rounds off a period of intense activity by the IES Technical Committee and its working panels such as can occur only when a definite goal is in sight and pressure is exerted to reach it. The British Zonal method, which the Report introduces, has already found application in the IES Glare Index system and this alone would justify its introduction. Although the Report is primarily concerned with the calculation of coefficients of utilisation its implications are much wider, for the high accuracy of the data and the rationalisation of lighting fittings classification combine to provide a sound base for the extension of the method to calculations formerly beyond the reach of practising light engineers. Thus Technical Report No. 2 brings us to the end of a long and honourable chapter in the history of lighting engineering. But what of the new chapter which is just beginning? It should be a good one all round, not least for lighting engineers who, at last, can trust their calculations and can quote authority for their recommendations. Now, surely, is the time for the next big heave. We want glare index data for luminous ceilings and daylighting; luminance tables to advance the production of the luminance code which is now only a matter of time, and we need to know far more about lighting depreciation, maintenance factors, reflection factors. All this work is under way and gathering momentum. The Society is on the march, and the lighting industry with it, but, while savouring the spice of these events, we should remember that the burden of the march has been borne up to now by a very small band who may be forgiven if they feel a little footsore. More than anything else the Society needs more such as they to help bring this bright future nearer to the present.

S.S. CANBERRA

The *Canberra*, which has just completed her maiden voyage, incorporates many of the latest, original and perhaps controversial ideas on the design of passenger-carrying liners both as regards structure and interior design. Particularly careful attention was given to the lighting. This article does not attempt to deal in detail with the lighting throughout the ship but draws attention to some of the more interesting features.

Length, overall 818 ft
Length, between perpendiculars 740 ft
Beam, moulded 102 ft
Load draught 32 ft 6 in.
Gross tonnage 45,270
First-Class accommodation 305 cabins, 548 passengers
Tourist accommodation 509 cabins 1,690 passengers
First-Class restaurant 334 seating
Tourist restaurant 704 seating
Cinema 332 seating
Launched March 16, 1960
Owners P & O - Orient Lines
Owners' Naval architect John West
Builders Harland & Wolff Ltd
Interior design
First-Class spaces Sir Hugh Casson, Timothy Rudle
Tourist-Class spaces John Wright, Frederick Mickman
Passengers' and crews' accommodation Miss Barbara Oakley
Lighting design and main equipment suppliers The General Electric Co Ltd

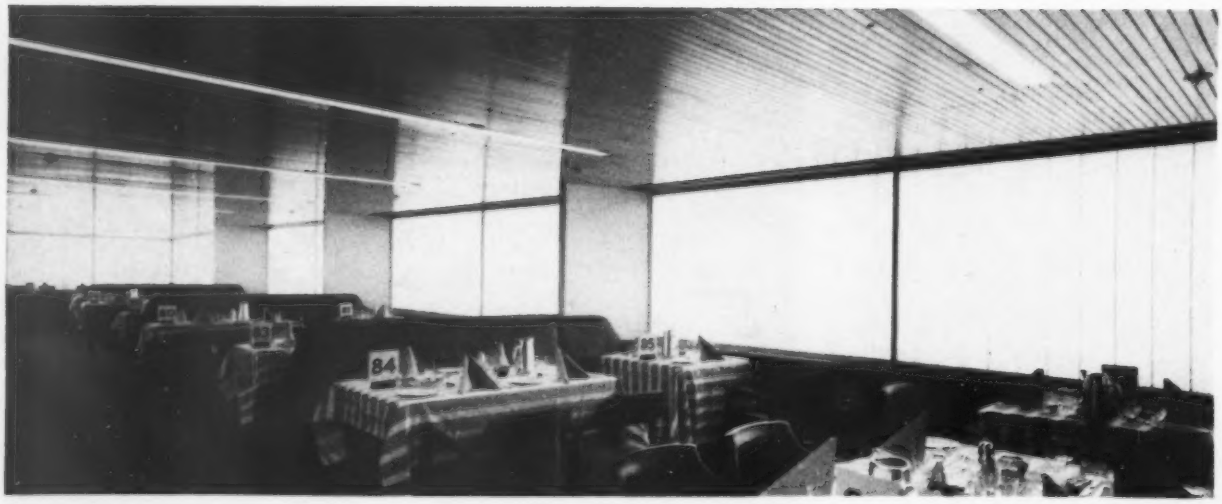
THE REVOLUTIONARY DESIGN of the *Canberra* has resulted in many 'firsts' in naval architecture and ship building practice. The superstructure, the largest all-welded ship's superstructure in the world, led to a saving in weight sufficient to enable an additional deck to be incorporated thus providing accommodation for some hundreds more passengers. No other liner afloat contains so great a variety of modern materials such as plastics, plastic laminates and glass fibre which have been used extensively on bulkheads, ceilings and other surfaces and for furnishings and decorative features.

The public spaces are very different from those normally found on ships and the designers have been very successful in their attempts to produce surroundings which are functional and yet are new and exciting. Special care has been given to the lighting throughout the ship, each public room being treated individually and each having its own special appeal.

Experience gained with other vessels put into service in recent years was considered when designing the lighting in the *Canberra*, but in addition a number of trials and demonstrations were arranged by the architects and owners at the GEC Research Laboratories where prototypes of cove lighting systems and various kinds of ceiling panels were made so that the most suitable and effective lighting could be designed for the many and varied spaces in the ship. As a result wide use has been made

Facing page; the central area of the first-class dining room showing the glass-fibre tungsten lamp fittings. Right; first-class entrance on the Promenade Deck lit by cold cathode tubing recessed into the ceiling without the use of diffusers.

Left; part of the luminous ceiling on the periphery of the Meridian Room. The cold cathode tubing above the louvers is spaced to give a gradient of illumination towards the bulkhead which is hung with white net curtains. Below; one side of the first-class dining room showing the luminous wall.



Right; looking down the spiral staircase from the Crow's Nest to the Meridian Room. The picture below, looking up the well, shows the cold cathode fittings below the handrail lighting the stair treads. The spotlamps at the top of the stairs can also be seen.

of cold cathode fluorescent tubing and of tungsten lamp fittings; hot cathode fluorescent tubes are also used in a number of places.

In the design of the public rooms the architects have used the lighting as part of their decorative schemes rather than to produce overall levels of illumination, lighting being used in varying intensities to accentuate points of interest or to create subdued areas of relaxation. As was to be expected the effort to produce something new and unusual gave rise to a number of problems which necessitated the closest collaboration between the architects, interior designers, lighting engineers and fittings designers. Not the least of the problems to be solved was the provision of acceptable and attractive lighting in those public rooms which are either on or below the water-line and hence have no portholes or natural lighting.

The first-class restaurant is one such room. Here the aim of the designers was to counteract the effect of the very large area of the room (which extends the full 100 ft width of the ship) and the low ceiling height. The room was therefore broken up visually by raising a portion of the ceiling, by sinking part of the floor in the centre of the room and by using pillar-casings to form screen walls to prevent the whole of the room being visible from any one point. Along each side of the room from sill to ceiling are large sheet plastic panels behind which are cold cathode tubes which give the effect of strong sunlight filtered through woven straw screens. In the centre of the room there are tungsten lamp ceiling fittings made of cylinders of glass fibre. Both of these lighting systems are used during breakfast and lunch; in the evenings the wall lighting is reduced to one single strip of cold cathode tubing in

Above; the Island Room in the tourist-class accommodation used for dancing, concerts and as a general games room showing the 'Perspex' brick-type tungsten lamp fittings.

Below left; the Cricketers' Tavern lit mainly by floodlamps concealed behind the semi-circular seating on the right. Below right; the shopping area where tungsten lamps are used in deep unglazed recesses.

Left; a corner of a first-class cabin during the day showing the adjustable berthlights. The fitting on the left can be placed in the other shoe fixed to the wall so that it can be used as a reading light when the divan is converted into a bed.

Centre; a tourist-class cabin lit by a flush-mounted ceiling fitting housing two 2 ft 20w fluorescent tubes and by 18-inch 15w tubes over the mirror. Right; close-up of the berthlight fitted with a 25w tubular lamp used in the tourist-class.

the sill which lights only the front of the plastic screen, and table lamps similar in style to the ceiling fittings are brought into use on each table.

The tourist-class restaurant, which is a good deal larger, is not quite so luxurious and the use of table lamps to provide intimate local lighting was precluded. General lighting is by means of tungsten ceiling fittings sited above each table and designed to serve two purposes. Each fitting houses two lamps on separate circuits each lamp having its own reflector; one of the lamps in each fitting gives a wide distribution and these are used during the day; during the evenings the other lamps, which are fitted with more concentrating reflectors, throw a narrow cone of light onto each table. White and gold cold cathode tubes in the outboard areas of the room are in use during the day but in the evenings the white tubes are switched off so that the room assumes a more intimate atmosphere.

The first-class lounge, known as the Meridian Room, was planned as one large area incorporating a series of curving walls behind which are smaller spaces used as writing rooms, bar, library etc., and in one of which is a spiral staircase leading up to the observation lounge (called the Crow's Nest). Typical of the problems which are encountered in lighting such spaces was the peripheral lighting of the Meridian Room where the architects wished to use a polystyrene one inch cell louvered ceiling extending several feet inboard with a maximum illumination inside the room falling off gradually to the outside. One of the conditions specified was that there should be no visible metal work and that the louvered ceiling should run the three sides of the space, following the curve of the forward end, unbroken by any supports. The available space between the ceiling surface and the deckhead was 2 ft. A proposed system of lighting was demonstrated by the GEC in which use was made of a grid of aluminium alloy extrusion to support the louvers and above which there were three lines of cold cathode tubing suitably spaced to give the required fall-off in illumination. Whilst it was expected that there would be a fair amount of pipework and trunking in the void above the louvers, some parts of the void were ultimately so tightly packed with other services that the available depth for the aluminium grid was barely 9 inches and in some cases the cold cathode electrode boxes could only just be fitted between the pipework.

A similar type of luminous ceiling is also used in the Crystal Room (a room for private dining or entertaining) and in the shops.

The spiral staircase between the Meridian Room and the observation lounge is lit by cold cathode tubing behind 'Perspex' diffusers fitted beneath the handrail; seen against the dark panelled 'fold' of the Meridian Room it appears as a bright white spiral. The staircase is also lit by low voltage spot-lamps in the ceiling of the observation lounge.

Peripheral lighting of the kind used in the Meridian Room is also used to light the translucent silver-white glass fibre walls in the tourist lounge and the glass mosaic walls in one of the two tourist class swimming pools. The latter, called the Alice Springs, has a low ceiling and the only part which could be lowered still further was that adjacent to the walls over the seating where it was possible to slope it to form a cavity in which the cold cathode tubing could be concealed.

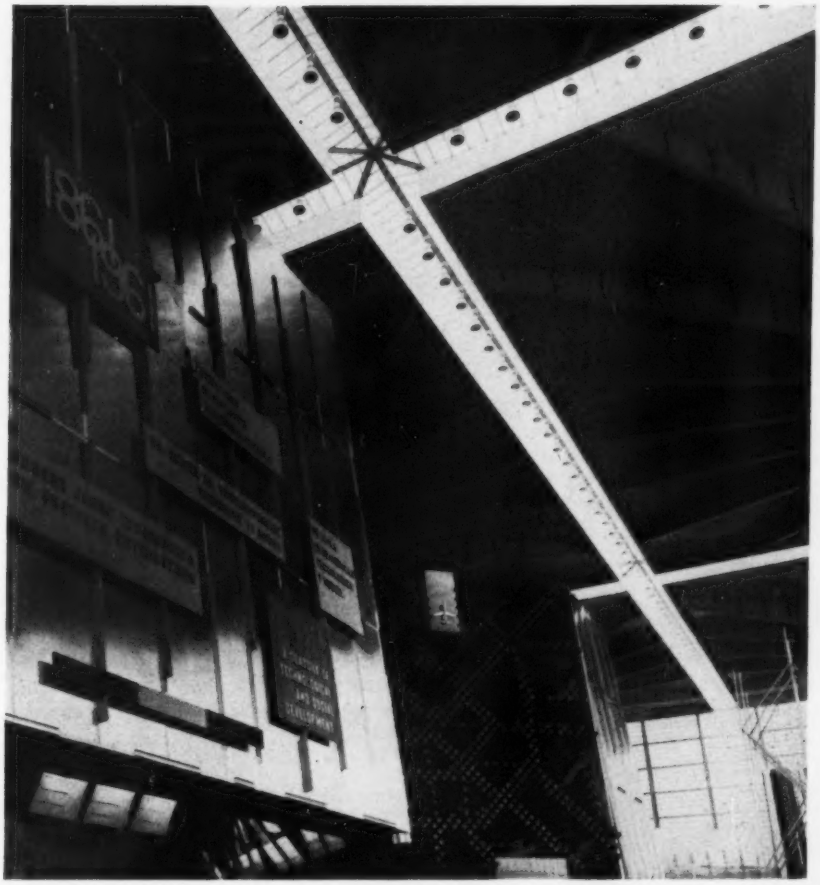
Two rooms which rely almost entirely on tungsten lamp lighting are the Island Room and the Cricketers' Tavern. The former, which is part of the tourist accommodation, is a large general-purpose room used for dancing and concerts in the evenings and as a games room and children's playground during the day. During hot weather it can be opened onto the deck on both sides. White and gold cold cathode tubing is concealed in the cornice of a dropped ceiling but the main lighting is from 'Perspex' brick-type fittings mounted direct onto the ceiling. Arranged in irregular groups they impart a lively sparkle to the room. The Cricketers' Tavern, the main tourist bar, was designed (with the help of Colin Cowdrey) to give the atmosphere of a 'pub' with cricket as the theme of the decoration. Life-size portraits of famous cricketers, bats, balls, caps, club ties—indeed the whole paraphernalia of cricket except the wicket—are used to create the desired atmosphere. A long narrow room, it is broken into sections by semi-circular seating behind which are small tungsten floodlights directed onto the cricketing displays. Additional lighting is provided by recessed tungsten lamps in the ceiling.

ITALIA 61, TURIN

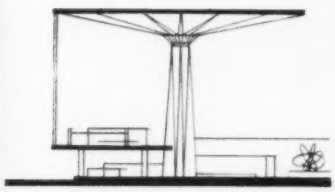
HAVING received comparatively little advanced publicity, 'Italia 61' comes as a magnificent surprise—on account of its scale and its sophistication. Turin, itself, is a most satisfying city, with its seemingly endless arcades of shops, its healthy bustle and, of course, its superb location—stretched out along the west bank of the river Po.

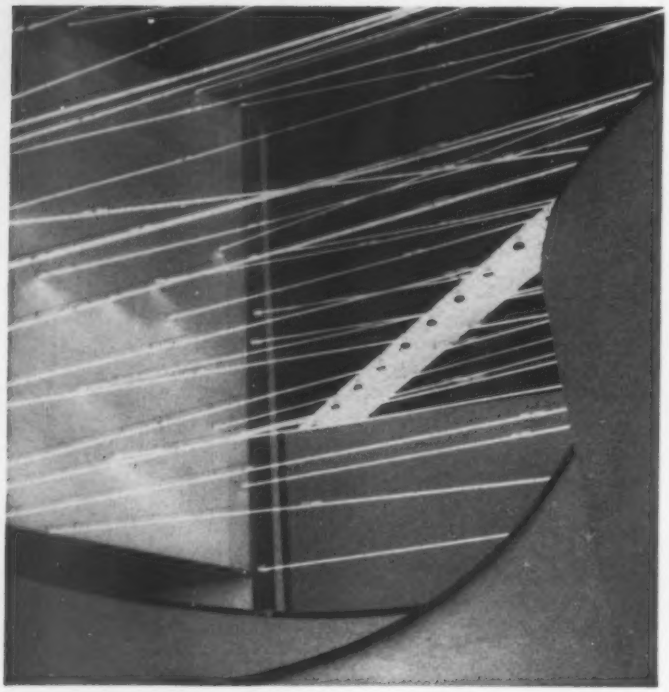
Some three miles from the city centre, but reached easily by excellent bus and trolleybus services, the exhibition site is a mile long and averages ¼ mile in width. It is traversed by a monorail and, within the site, specially designed open taxis, protected from the sun by fringed canopies, ply for hire. The two principal buildings, both permanent ones, are the Palace of Labour (see LIGHT AND LIGHTING, August 1961, p. 246) and a near-circular exhibition hall resembling Saarinen's new building at Ildewilde Airport. The former houses an international exhibition the theme of which is the role that labour has played in 100 years of industrial and scientific development. In addition to Italy's own contributions to this theme, sixteen other countries have pavilions under the one roof. In the exhibition hall there are displays illustrating a century of change in social life and customs, including costume, travel, furniture and the fine arts; while perhaps the most interesting part of the whole exhibition for the visitor from abroad is the regional section, comprising nineteen two-storey pavilions strung out along the river bank, but connected by bridges and covered ways. These pavilions give a picture of the geography, history, culture and economic life of each region, their *décor* being a reflection of the raw materials and natural features of the area, while at ground level, in most instances, there is a restaurant serving regional dishes.

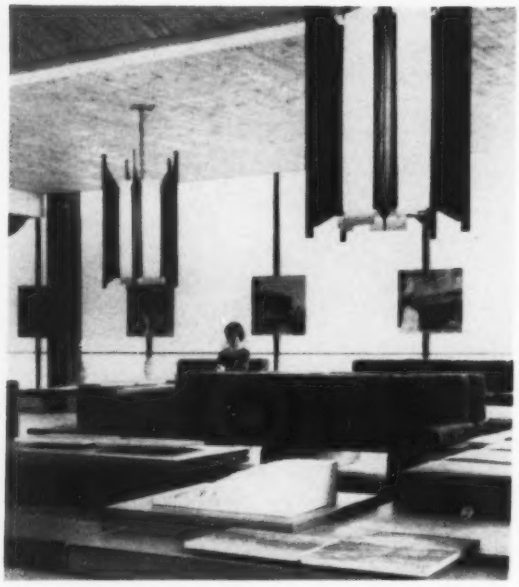
In Italy's abundant daylight, natural lighting suffices in many of the buildings for most of the day, except, of course, where it has been deliberately excluded for dramatic effect, and various methods have been used for diffusing an excess of direct sunlight. In both main pavilions artificial lighting is mostly from high-mounted projectors, which tend to become a source of glare, though attention is drawn away from them by the spotlighting of displays. In the regional pavilions, lighting is unobtrusive, being mainly from spotlights directed on to the displays and on to light-coloured reflecting surfaces, though, regretably, in a few instances, directed into the eyes of the passer-by.



Opposite page and left: Designed by Pier Luigi and Antonio Nervi, in collaboration with Gino Covre, the Palace of Labour comprises sixteen mushroom-shaped concrete columns, the extended steel heads of which are 130 ft square. The building is over 80 ft high and covers an area of 275,000 sq ft. Between the column heads strips of glazing appear as white bands against the grey-painted welded steel, while the periphery of the building is clad with glass curtain walling protected on all four sides by horizontal aluminium louvers. At night, general lighting is from rows of projector units, each housing a 400 watt colour-corrected mercury lamp, suspended along the centre lines of the roof glazing. Below, concrete fan vaulting of mezzanine soffit in Finnish section of Palace of Labour, with lighting diffusers of opal plastics filling some of the recesses. Below left, diffuser fitting for local lighting of pedestrian walks and (lower picture) reflector fitting for lighting kerb of roadway.







ITALIA 61 *(continued)*

1 | 2
3 | 4

1. Cold-cathode tubing, green in colour, is feature of power and energy exhibit of Italian section of the Palace of Labour. Lighted intermittently, the tubing casts a green glow over a substantial area of the pale grey roof. 2. Decorative ceiling structure of laminated timber in balcony area occupied by Yugoslav exhibit is lit by numerous tungsten spotlamps in adjustable silver and black reflectors. 3. In ground floor area of the Piedmont pavilion—one of the nineteen regional pavilions of the exhibition—decorative lighting from random arrangement of fluorescent lamps, suspended from ceiling by piano wire twisted round the tubes and connected to the remote control gear without the benefit of any form of lamp-holder. 4. Rare example of decorative fittings, seen in the Valle d'Aosta pavilion. Based in shape on a motif traditional to this region, they have diffusers of opal plastics and fins of matt-black aluminium.

Factors Affecting the Choice of Light Sources for Main Road Lighting

By F. H. PULVERMACHER, AMIEE

THE AIM OF street lighting authorities and lighting engineers is to light trafficways in their charge to the best of their ability and means, a desire modulated by the embarrassing multitude of light sources available for the purpose.

In this article an attempt is made to assess those factors which bear upon the selection of a light source for use on main roads. Such an appraisement must necessarily be limited to those factors affecting the economics of street lighting even though other factors such as daylight appearance and colour rendering also have to be taken into account. Accordingly only basic costs are considered—it being the prerogative of the providers of street lighting to decide what other costs shall be met on the score of amenity and harmony.

Equipment

The cost of equipment is a capital one and non-recurring. On the other hand lighting costs are assessed upon an annual basis. Such capital costs are generally met by means of a loan which is repaid, together with interest, over a number of years. To cover this an annual repayment equal to 8 per cent of the capital cost may be assumed.

Basically a street lighting unit comprises lamps, lantern, column, ancillary gear, wiring, and service connection. The last two items will be the same whatever the light source and will not affect any comparison (though strictly speaking the wiring of ancillary gear will add a small amount) and their costs have therefore been omitted from the present calculations. Lamps are a consumable item and are dealt with separately. This leaves ancillary gear, lantern and column as components whose cost is related to the type of light source selected.

In general the cost of columns is dependent on their design and the material used in their construction rather than on the light source. Lantern costs are not dissimilar. The main cost variation therefore lies with the use or otherwise of ancillary gear. In practice the yardstick is the cost of lighting a unit length—generally a mile—of road since different lamps may entail different average spacings with a consequent adjustment in costs. This complication will be considered later on.

The two predominant materials for columns are steel and reinforced concrete the costs of which are compared in Table 1. The costs are intended as typical and, subject to the considerable variation that design will entail, it is seen that these are comparable, steel being possibly the cheaper in first cost. Any such advantage disappears if painting—a recurring charge—is taken into account when assessing annual costs. The only differences due to the type of the light source in the 25 ft. range is that occasioned by the 3 × 80w tubular fluorescent (MCF/U) lantern when a more robust column is needed. Surprisingly enough the 35 ft steel column costs little more than its 25 ft counterpart, the omission of a bracket at the greater height counteracting to a considerable extent the cost of the longer shaft. Erection costs are difficult to estimate closely and fluctuate considerably according to local circumstances. Experience with the 35 ft mounting is meagre and difficult to estimate.

Street lighting columns are subject to a greater degree of amenity criticism than almost any other item of street furniture. Such fitness-of-scene-value cannot be measured in terms of pounds, shillings and pence, and the deciding factor here will be the sensibility of the selectors guided by their technical advisers. Obviously any costs engendered by amenity considerations must be kept out of basic calculations as given in this article.

Costs directly affected by the light source then are those in respect of the lantern and the ancillary gear. Table 2 gives typical costs of these items. The annual costs of columns (omitting painting) have also been transferred from Table 1 as certain light sources dictate special column requirements in the way of strength or length. For the sake of simplicity only steel

Table 1

Typical costs of lighting columns

	Concrete		Steel	
	Capital cost	Annual cost	Capital cost	Annual* cost
	£ s. d.	£ s. d.	£ s. d.	£ s. d.
25 ft.				
Column	23 0 0		22 0 0	
Erection	7 10 0		7 0 0	
Total	30 10 0	2 8 9	29 0 0	2 6 5
52 ft. (3 × 80 W, MCF/U)				
Column	25 0 0		24 0 0	
Erection	8 10 0		8 0 0	
Total	31 10 0	2 13 8	32 0 0	2 11 3
35 ft.				
Column			27 10 0	
Erection			10 0 0	
Total			37 10 0	3 0 0

* In addition steel columns will incur an extra charge for painting

Table 2
Annual equipment costs

	Typical Capital Costs												Annual Costs								
	Lantern			Choke or transformer			Capacitor			Starter switch			TOTAL			Lantern etc.			Steel col. ex Table 1			TOTAL		
	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.	£	s.	d.
GLS																								
300–500w	9	0	0										9	0	0	14	5		2	6	5	3	0	10
SO/H & SOI/H																								
85w	9	10	0	4	10	9	1	4	9				15	5	6	1	4	5	2	6	5	3	10	10
140w	9	10	0	5	7	6	1	10	9				16	8	3	1	6	3	2	6	5	3	12	8
200w	17	10	0	5	19	9	1	13	3	7	6		25	10	6	2	0	10	3	0	0	5	0	10
280w	17	10	0	10	15	0	3	1	6				31	6	6	2	10	1	3	0	0	5	10	1
MA/V, MB/U & MBF/U																								
250w	13	5	0	4	12	3	1	7	6				19	4	9	1	10	9	2	6	5	3	17	2
400w	13	5	0	5	5	9	1	13	3				20	4	0	1	12	4	2	6	5	3	18	9
MCF/U																								
3 × 80w	43	0	0	6	5	9	1	10	9	1	1	6	51	18	0	4	3	0	2	11	3	6	14	3

Table 3
Light output of lamps

	Average lumens throughout life (L)			Average life (Hrs)			Lumen-hours (LH × 10^6)		
	1937	1953	1961	1937	1953	1961	1937	1953	1961
GLS									
300w	4,140	4,300	4,300	1,000	1,000	1,000	4·14	4·3	4·3
500w	7,500	7,700	7,700	1,000	1,000	1,000	7·5	7·7	7·7
SO/H									
85w	4,700	5,400	5,525	2,500	4,000	4,000	11·75	21·6	22·1
140w	8,100	9,000	9,100	2,500	4,000	4,000	20·25	36·0	36·4
SOI/H									
85w			6,300			4,000			25·2
140w			9,900			4,000			39·6
200w			18,400			4,000			73·6
280w (short)			16,800			4,000			67·2
280w (long)			22,400			4,000			89·6
MA/V									
250w	9,000[2]	8,000	8,750	1,500	3,000	4,000	13·5	24·0	35·0
400w	18,000[2]	14,400	15,600	1,500	3,000	4,000	27·0	43·2	62·4
MB/U									
250w			10,000			5,000			50·0
400w			17,000			5,000			85·0
MBF/U									
250w			10,100			5,000			50·5
400w		12,800[1]	17,500		2,500[1]	5,000		32·0[1]	87·5
MCF/U									
80w	2,800[3]	2,600	4,480	2,000	5,000	5,000	5·6	13·0	22·4
3 × 80w	8,400[3]	7,800	13,440	2,000	5,000	5,000	16·8	39·0	67·2

[1] Type MAF/U [2] Initial lumens [3] 1940. Not in production in 1937

columns are included and painting costs omitted. Chart 1 shows this information in diagrammatic form. A point of interest is the cost of the 3 × 80w MCF/U lantern and its associated heavy column which makes this equipment the most expensive, a fact which has evidently prevented a very much greater use of what is otherwise an economic and excellent light source.

Light sources

Whilst the selection of equipment may be a matter of personal taste rather than one of economics, the selection of the light source is a calculated one—always assuming that a monochromatic light is no bar. Light sources in common use are:

TUNGSTEN FILAMENT	(GLS)
MERCURY VAPOUR	
High Pressure	
Glass arc tube	(MA/V)
Quartz arc tube	(MB/U)
Quartz arc tube, fluorescent bulb	(MBF/U)
Low Pressure	
Long glass tube	(MCF/U)
SODIUM VAPOUR	
Separate jacket	(SO/H)
Integral jacket	(SOI/H)

An assessment made in 1953 indicated that sodium lamps were the most economical light source. Amongst views then advanced were that the high pressure mercury lamp would disappear from the street lighting scene and that the use of tubular fluorescent lamps would increase considerably. Neither of these events has taken place.

During the intervening eight years new lamps have been introduced and existing ones modified. Notable in this progression are the high wattage sodium lamps (200 and 280 watts), and integral jacket construction (type SOI/H) which is now available for all sizes of sodium lamps. High pressure mercury vapour lamps of the quartz tube and fluorescent patterns are now available in the higher wattage sizes used for street lighting whilst the life now obtained is 4,000 to 5,000 hours. Efficiencies have also increased. Table 3 shows the average light output, life, and lumen-hours for various types of high wattage lamps available in 1937, 1953, and 1961. Chart 2 gives the same information in a diagrammatic form.

A point to notice is the increase in the lamp types available. In 1937 the lamp providing the most light was the 400w MA/V with 18,000 (initial) lumens. The 1953 figure of 14,400 and that for 1961 of 15,600 appear to be retrograde steps but this is not so as the 1938 figure is an optimistic one for the commencement of life whilst the two post-war figures are the average throughout life. (Because of the need for caution in comparing the 1937 figure, the upper boundaries of the areas repre-

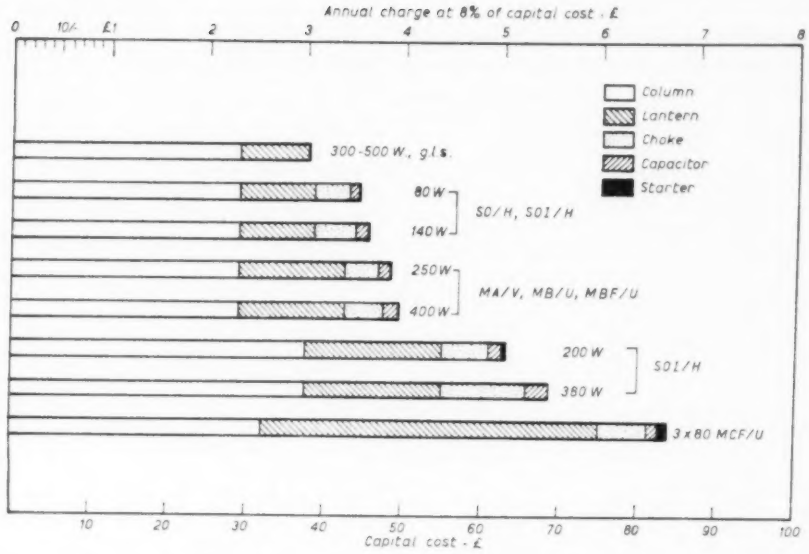


Chart 1. Make-up of equipment costs; service and initial lamp costs excluded.

senting the total lumen hours in Chart 2 are broken.) Due to the much longer life now obtained, the total lumen-hours have greatly increased over the intervening years; the increase is even greater than is apparent from Chart 2 if the average and not the initial lumen output for 1937 is taken as the reference.

It is of little use, however, having lamps capable of many lumen-hours if the cost of each lumen-hour is disproportionately high.

Energy

The cost of electrical energy forms a considerable part of the cost of providing streetlighting. The tariffs of the various Electricity Boards must necessarily be different, related as they are to times of use with consequent incidence upon peak demand and to the bulk supply charges of the Central Electricity Generating Board which vary according to distance from coal fields, transmission costs, load factor, etc. Information supplied by a number of Lighting Authorities, selected at random, gave a variation in the price per kWh. from 1·120*d.* to 1·879*d.*, the mean being 1·446*d.* This compares closely with a national average for public lighting of 1·456*d.* derived from the published figures of the Electricity Boards. The published figure for 1953 was 1·393*d.*

Chart 2. Comparative light output and life of lamps (Each area gives to scale the total light in lumen-hours during life of lamp).

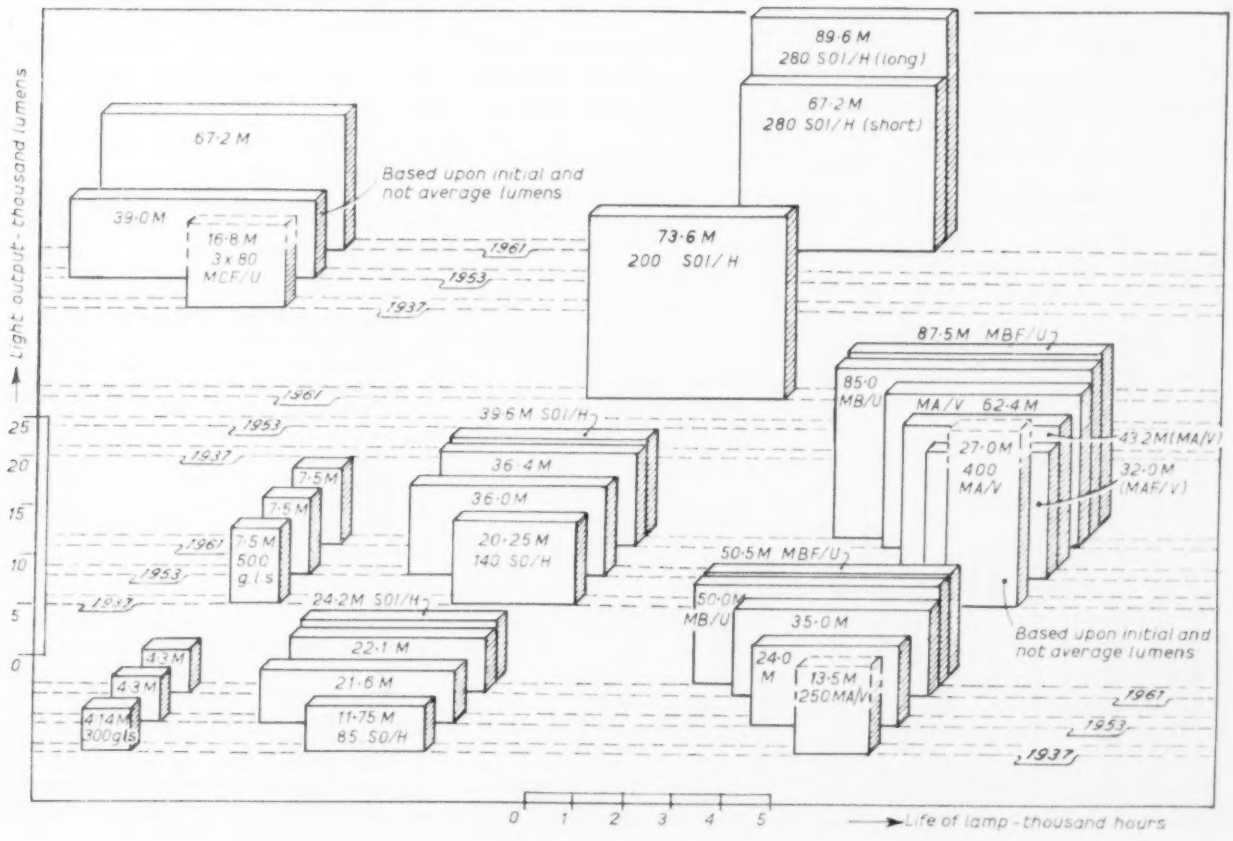


Table 4

Total cost of providing one million lumen-hours

Size and type of lamp (gross watts in brackets)	Lamp Costs: Each 1953	Lamp Costs: Each 1960	Lamp Costs: For 4,000 hrs. use. Life as Table 3: 1953	Lamp Costs: For 4,000 hrs. use. Life as Table 3: 1960	Energy Costs: 1953 (1·393*d.* per kWh)	Energy Costs: 1960 (1·456*d.* per kWh)	Addition to Basic attendance for long lamp: 1953	Addition to Basic attendance for long lamp: 1960	Equipment cost ex Table 2: 1953	Equipment cost ex Table 2: 1960	TOTAL COSTS: 1953	TOTAL COSTS: 1960	Lumen-hours per annum (millions): 1953	Lumen-hours per annum (millions): 1960	Cost per million lumen-hrs: 1953	Cost per million lumen-hrs: 1960
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
	£ *s. d.*	£ *s. d.*	£ *s. d.*	£ *s. d.*	£ *s. d.*	£ *s. d.*	*s. d.*	*s. d.*	£ *s. d.*	£ *s. d.*	£ *s. d.*	£ *s. d.*	LH × 10^6	LH × 10^6	*s. d.*	*s. d.*
GLS																
300w	5 3	5 1	1 1 0	1 0 4	6 19 4	7 5 8			2 5 0	3 0 10	10 5 4	11 6 10	17·2	17·2	11 11	13 2
500w	6 9	6 4	1 7 0	1 5 4	11 12 2	12 2 8			2 5 0	3 0 10	15 4 2	16 8 10	30·8	30·8	9 10	10 8
SO/H																
85 (107)w	2 9 2	2 10 5	2 9 2	2 10 5	2 9 8	2 11 11			2 11 8	3 10 10	7 10 6	8 13 2	21·6	22·1	7 0	7 9
140 (170)w	2 17 10	2 14 11	2 17 10	2 14 11	3 18 11	4 2 6			2 12 6	3 12 8	9 9 3	10 9 1	36·0	36·4	5 3	5 9
SOI/H																
85 (107)w		2 17 0		2 17 0		2 11 11				3 10 10		8 19 9		25·2		7 2
140 (170)w		2 19 3		2 19 3		4 2 6				3 12 8		10 14 5		39·6		5 5
200 (235)w		4 2 6		4 2 6		5 14 0		15 0		5 0 10		15 12 4		73·5		4 3
280 (340)w:																
Short		5 18 6		5 18 6		8 5 0		15 0		5 10 1		20 8 7		67·2		6 1
Long		5 18 6		5 18 6		8 5 0		15 0		5 10 1		20 8 7		89·6		4 7
MA/V																
250 (267)w	1 16 0	1 16 9	2 8 0	1 16 9	6 4 0	6 9 7			2 15 0	3 17 2	11 7 0	12 3 6	32·0	35·0	7 1	7 0
400 (425)w	1 19 2	2 0 6	2 12 3	2 0 6	9 17 4	10 6 3			2 16 6	3 18 9	15 6 1	16 5 6	57·6	62·4	5 4	5 3
MB/U																
250 (267)w		2 0 6		1 12 5		6 9 7				3 17 2		11 19 2		40·0		6 0
400 (425)w		2 4 3		1 15 5		10 6 3				3 18 9		16 0 5		68·0		4 9
MBF/U																
250 (267)w		3 3 0		2 10 5		6 9 7				3 17 2		12 17 2		40·4		6 4
400 (425)w	2 14 4	4 17 6	4 6 11	3 18 0	9 17 4	10 6 3			2 16 6	3 18 9	17 0 9	18 3 0	51·2	70·0	6 8	5 3
MCF/U																
3 × 80 (285)	1 19 0	1 16 0	1 11 2	1 8 10	6 12 4	6 18 3	11 6	15 0	4 10 0	6 14 3	13 5 0	15 16 4	31·2	53·6	8 6	5 11

Note: Lamp costs of type SO/H include proportional cost of vacuum jacket which is estimated to have life equal to 4 lamps.

Table 5

Economic order of lamps based upon cost of providing one million lumen-hours

Economic order	1953 Size and type	1953 Cost per M lumen-hrs.	1961 Size and type	1961 Cost per M lumen-hrs.
		s. d.		*s. d.*
1	140 SO/H	5 3	200W SOI/H	4 3
2	400 MA/V	5 4	280 SOI/H Long	4 7
3	400 MA/F	6 8	400 MB/U	4 9
4	85 SO/H	7 0	400 MA/V 400 MBF/U	5 3
5	250 MA/V	7 1	140 SOI/H	5 5
6	3 × 80 MCF/U	8 6	140 SO/H	5 9
7	500 GLS	9 10	3 × 80 MCF/U	5 11
8	300 GLS	11 11	250 MB/U	6 0
9			280 SOI/H Short	6 1
10			250 MBF/U	6 4
11			250 MA/V	7 0
12			85 SOI/H	7 2
13			85 SO/H	7 9
14			500 GLS	10 8
15			300 GLS	13 2

Maintenance

Maintenance costs vary in different places and it is often difficult or impossible to separate different items. It is therefore difficult to arrive at a representative cost for routine maintenance. As, however, the cost of servicing a lamp is basically the same whatever the local variation, this item could be omitted without affect upon the comparison between lamp types being established. Some lanterns (e.g. 200w SOI/H and the 3 × 80w MCF/U) take a little longer to service; it is thought sufficient for the present purpose if a surcharge of 15*s.* for these two types is made though the exact amount may vary according to local circumstances.

Total costs

The various figures discussed in the preceding paragraphs have been co-ordinated in Table 4. The calculations have been based upon all-night lighting (as all good street lighting should be) and the costs shown are annual ones. Columns 2–5 refer to lamp costs based upon the anticipated life (usually conservative figures) as supplied by manufacturers. Energy, additional

attendance, and equipment costs are given in columns 6–11, the total costs being given in columns 12 and 13. The Table is extended to cover total light output (columns 14–15) and cost of light (columns 16–17).

There are several points of interest. In both 1953 and 1961 the 85w SO/H has the lowest annual cost per point (columns 12–13) closely followed by the 85w SOI/H. Unfortunately the illumination given by the 85w lamp is insufficient for our main roads. Furthermore, any effective comparison of the annual cost of one lamp with another must take into account the total light output (columns 14–15) and such a comparison (columns 16–17) show that the seemingly costly 200w SOI/H is in fact the cheapest followed by the 280w SOI/H (Long). Table 5 sets out columns 16 and 17 of Table 4 in ascending order.

To have established the lamp which provides the most light for the least cost is not the finish however. In a street lighting installation lamps are spaced in accordance with the Code of Practice for Street Lighting (CP1004) entailing the provision of a lamp every 120 ft. Road conditions may be such that adequate lighting can be given by a lower power lamp and as this will mean a lower cost per lamp point, the cost of lighting per mile is less than if a more efficient lamp had been used. Table 6 gives this cost on the basis of 120 ft spacing (44 per mile) excepting the high wattage SOI/H lamps where 150 ft spacing (35 per mile) has been allowed due to the greater mounting height of 35 ft. Chart 4 shows the relationship between the cost of lighting per mile and the amount of light provided by various types of light sources.

It is obvious from Charts 3 and 4 that

Table 6

Annual cost of lighting one mile of road (excluding service cost and basic attendance)

Type and size of lamp	No. of points per mile	Lumens (75% lantern efficiency)			ANNUAL COST	
		per lamp	per 100 ft. (CP 1004)	per mile	per lamp (T. 4, Col. 13)	per mile
1	2	3	4	5	6	7
		L	*L*	*L* (×1000)	£ *s.* *d.*	£
GLS						
300	44	3,230	2,690	142	12 6 10	543
500	44	5,780	4,800	254	17 8 10	767
SO/H						
85	44	4,150	3,450	182	9 13 2	435
140	44	6,820	5,680	300	11 9 1	508
SOI/H						
85	44	4,730	3,940	209	9 19 9	439
140	44	7,420	6,200	326	11 14 5	526
200	35	13,820	9,220	485	17 5 8	605
280 (short)	35	12,600	8,400	439	22 1 11	773
280 (long)	35	16,800	11,200	589	22 1 11	773
MA/V						
250	44	6,550	5,480	289	13 3 6	579
400	44	11,700	9,750	514	17 5 6	760
MB/U						
250	44	7,500	6,260	330	12 19 2	570
400	44	12,750	10,600	562	17 0 5	749
MBF/U						
250	44	7,570	6,300	333	14 6 2	630
400	44	13,120	10,900	577	19 3 0	843
MCF/U						
3×80	44	10,080	8,400	442	16 19 8	747

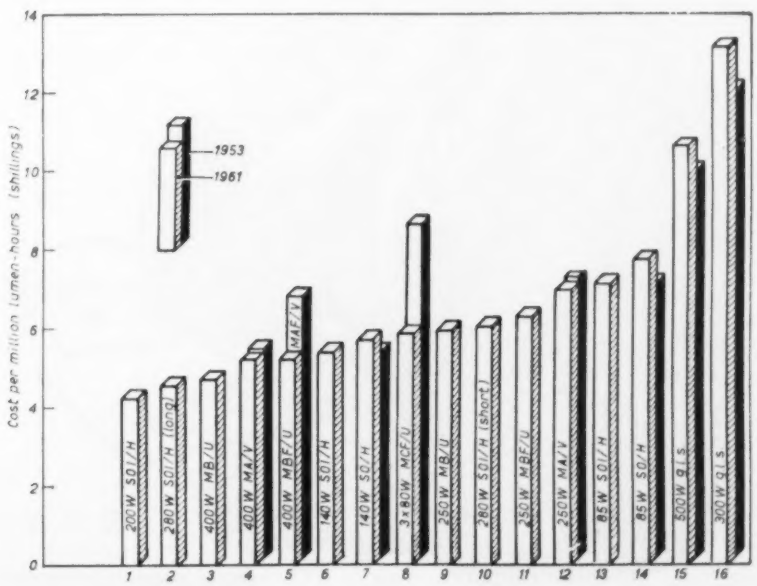


Chart 3. Annual cost per million lumen-hours.

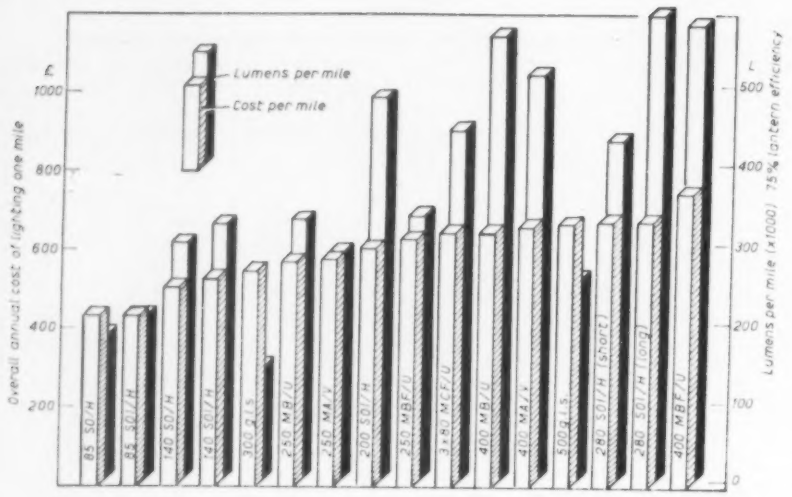
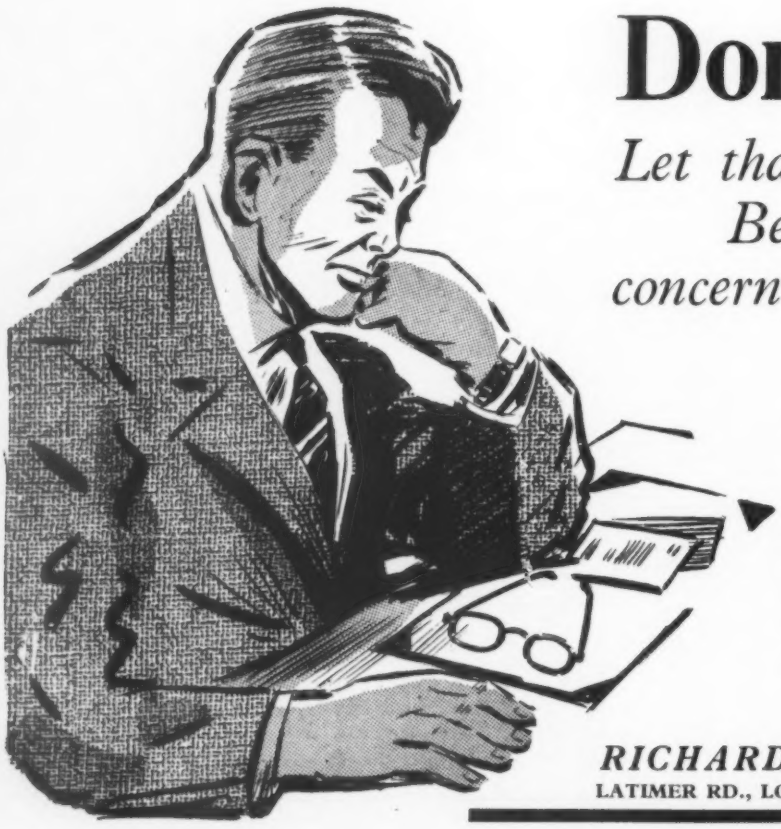


Chart 4. Annual cost per mile and associated road illumination.

there is no hard and fast rule for the selection of the best lamp for any given purpose although the information set out should enable those with a clear knowledge of the standard and form of lighting required to select a suitable light source and to obtain an approximation of the running cost of the installation.

Conclusion

From the data presented it is apparent that the advent of so many efficient light sources has both eased and yet made more complex the lot of the street lighting engineer. Eased because of his ability to light our roads to new standards at a lesser cost than would have been thought possible had not the discharge lamp come into being; more complex because of the multitude of pros and cons to be considered, not omitting those abstract qualities calling for taste and judgment. It would indeed be a poor world if these were thrust aside as not worth such extra cost as may be called for. Let us remember this as we ponder our columns of figures.



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Glare Index Evaluation

BY E. ROWLANDS
B.SC, A.INST.P, AMIEE

GLARE INDEX EVALUATION by the method given in Section (11) of the new IES Code has aroused great interest and has been used successfully by many lighting engineers. Experience has shown, however, that its correct use would be facilitated by further guidance on the procedure and the interpretation of the data with some additional information including explanations of the background to the method.

The IES Technical Committee invites queries and comments on the method: if these are of sufficient general interest, discussion of them will be published with any additional data from the Committee. The following questions and answers are the first to be published and are based on queries which have been raised by users.

(1) On what basis should the Initial Glare Index interpolation in Tables 3.1-3.10 for Flux Fraction be made?

This interpolation should be made using the ratio of the Upper Flux Fraction to the Lower Flux Fraction (Flux Fraction Ratio) and not the values of the Flux Fractions themselves. Therefore, the three sets of data in each table are applicable as follows:

Upper Flux Fraction Lower Flux Fraction	0% 100%	25% 75%	50% 50%
Flux Fraction Ratio	0	0·33	1·0

A linear interpolation between these values of Flux Fraction Ratio is recommended.

The value of the Flux Fraction Ratio can also be obtained, of course, as the ratio of the Upward Light Output Ratio to the Downward Light Output Ratio.

Example

Installation Data
- Room Dimensions: X = 4H, Y = 8H
- Reflection Factors: Ceiling 70%, Walls 50%, Floor 14%

Lighting Fitting Data
- BZ Classification: BZ 5
- Upward Light Output Ratio: 10%
- Downward Light Output Ratio: 72%

$\therefore$ Flux Fraction Ratio $= \frac{10}{72} = 0{\cdot}14$

From Table 3.5

Flux Fractions	Flux Fraction Ratio	Initial Glare Index
Upper 0% Lower 100%	0	25·5
Upper 25% Lower 75%	0·33	22·8
	By linear interpolation	
	0·14	24·4

(2) On what basis should the Initial Glare Index interpolation in Tables 3.1-3.10 for Room Dimensions be made?

The interpolation for values of X and Y should be made on a linear basis between consecutive quoted values, considering only one of the dimensions as variable at a time.

Example

Installation Data
- Room Dimensions: X = 7H, Y = 9·5H
- Reflection Factors: Ceiling 70%, Walls 50%, Floor 14%

Lighting Fitting Data
- BZ Classification: BZ6
- Upward Light Output Ratio: 17% } Flux Fraction Ratio = 0·33
- Downward Light Output Ratio: 51% }

The first interpolation (in the chart below), is for Y = 9·5H between the values for Y = 8H and 12H, keeping X = 4H constant, i.e. between 22·9 and 23·8: this gives a value of 23·24; the second decimal place is retained until the final interpolation.

The next interpolation is a similar one for Y = 9·5H keeping X = 8H constant, i.e. between 24·3 and 25·3: this gives a value of 24·68.

The final interpolation is for X = 7H between the values for X = 4H and 8H, keeping Y = 9·5H constant, i.e. between 23·24 and 24·68: this gives a value of 24·3.

The interpolation chart below can be adapted for the other interpolations required in this method of Glare Index evaluation (see, for example, Question 4).

Values from Table 3.6			Interpolated Values			
X	Y	Initial Glare Index	Y	Initial Glare Index	X	Initial Glare Index
4H	8H	22·9	9·5H	23·4		
	12H	23·8			7H	24·3
8H	8H	24·3	9·5H	24·68		
	12H	25·3				

(3) What Initial Glare Index values should be used for room dimensions greater than the maxima quoted (X = 12H and Y = 12H) in Tables 3.1-3.10?

Since the change in value from that quoted for the maximum dimensions is very small, it is recommended that for a room dimension greater than 12H, the value corresponding to 12H should be used.

Glare Index Evaluation (continued)

(4) On what basis should the Initial Glare Index interpolation in Tables 3.1-3.10 for Room Surface Reflection Factors be made?

Room surface reflection factors are seldom known with sufficient accuracy to make interpolation between the published values have any real meaning. If, however, interpolation is reasonable, it should of course be done by considering only one of the reflection factors as variable at a time.

Data should not be extrapolated for ceiling and wall reflection factors beyond 30% towards 0%.

Example

Installation Data

Room Dimensions X=4H, Y=12H

Reflection Factors Ceiling 60%, Walls 40%, Floor 14%

Lighting Fitting Data

BZ Classification BZ 3

Upward Light Output Ratio 0% } Flux Fraction

Downward Light Output Ratio 70% } Ratio = 0

Values from Table 3.3			Interpolated Values			
Ceiling Reflection Factor	Wall Reflection Factor	Initial Glare Index	Wall Reflection Factor	Initial Glare Index	Ceiling Reflection Factor	Initial Glare Index
70%	50%	20·8				
			40%	21·45		
	30%	22·1				
					60%	21·7
50%	50%	21·4				
			40%	22·00		
	30%	22·6				

(5) On what basis should the interpolation for the three Conversion Terms in Table 4 be made?

The interpolation for each of these conversion terms can be made by linear interpolation between consecutive quoted values.

Lighting engineers may, however, find it an advantage to read the required interpolation from graphs of the three relationships: this will also give a very slight increase in accuracy. These Conversion Graphs are given in Figs. 1, 2 and 3. The relationships for Downward Flux F and Luminous Area A are logarithmic, and therefore in Figs. 1 and 2 a log. scale has been used for F and A and a linear scale for the conversion terms giving a straight line graph. The relationship for Height H, however, is not a simple one, and the conversion graph in Fig. 3 is given as a smooth curve using linear scales for both parameters.

Example

From Table 4

Downward Flux (lumens)	Conversion Term
3000	+2·9
5000	+4·2
By linear interpolation	
4000	+3·55

The value obtained from the log.-linear graph in Fig. 1 is +3·6.

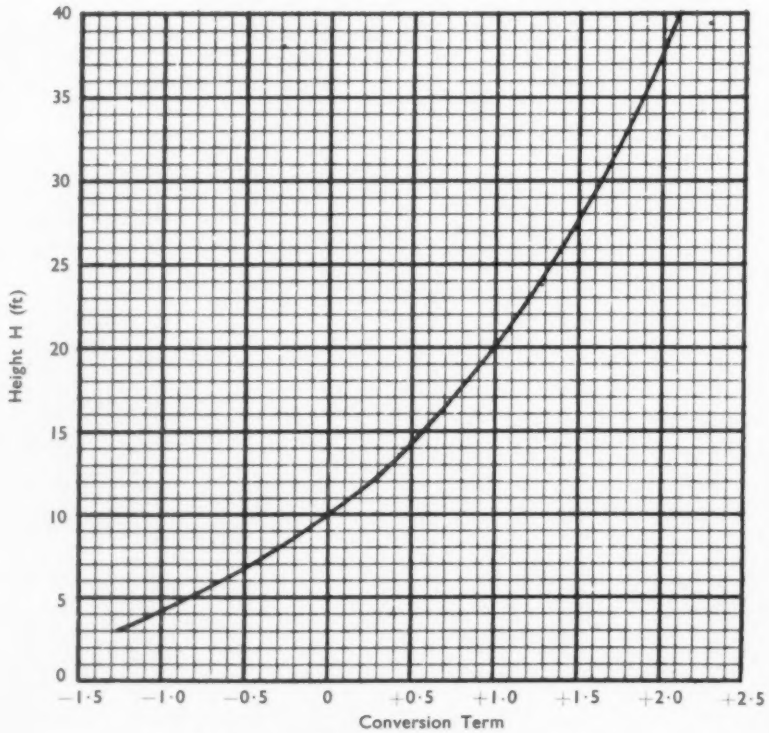

Fig. 3. Conversion graph for height above 4 ft eye level

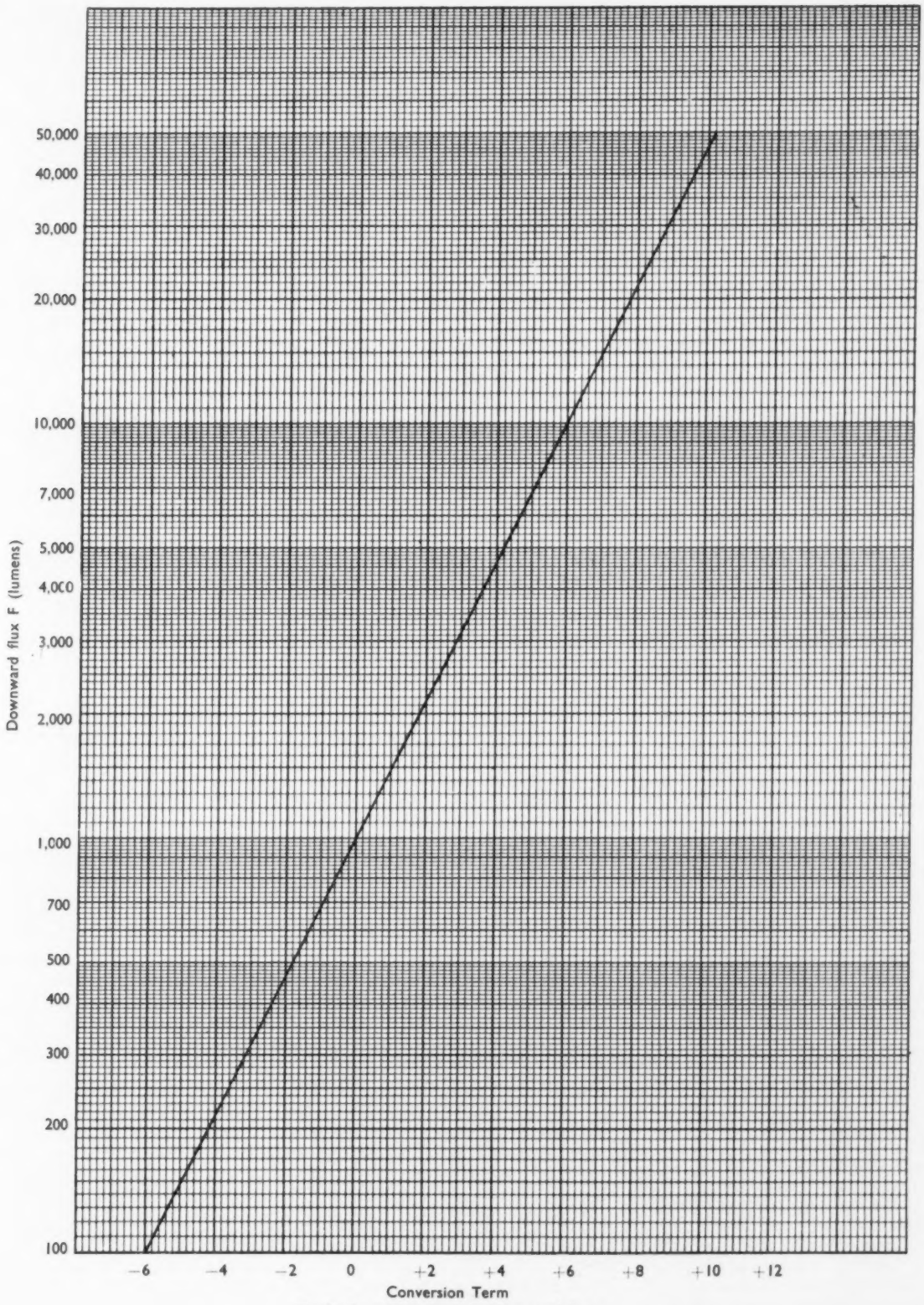

Fig. 1. Conversion graph for downward flux

(For Fig. 2 and continuation of article see over)

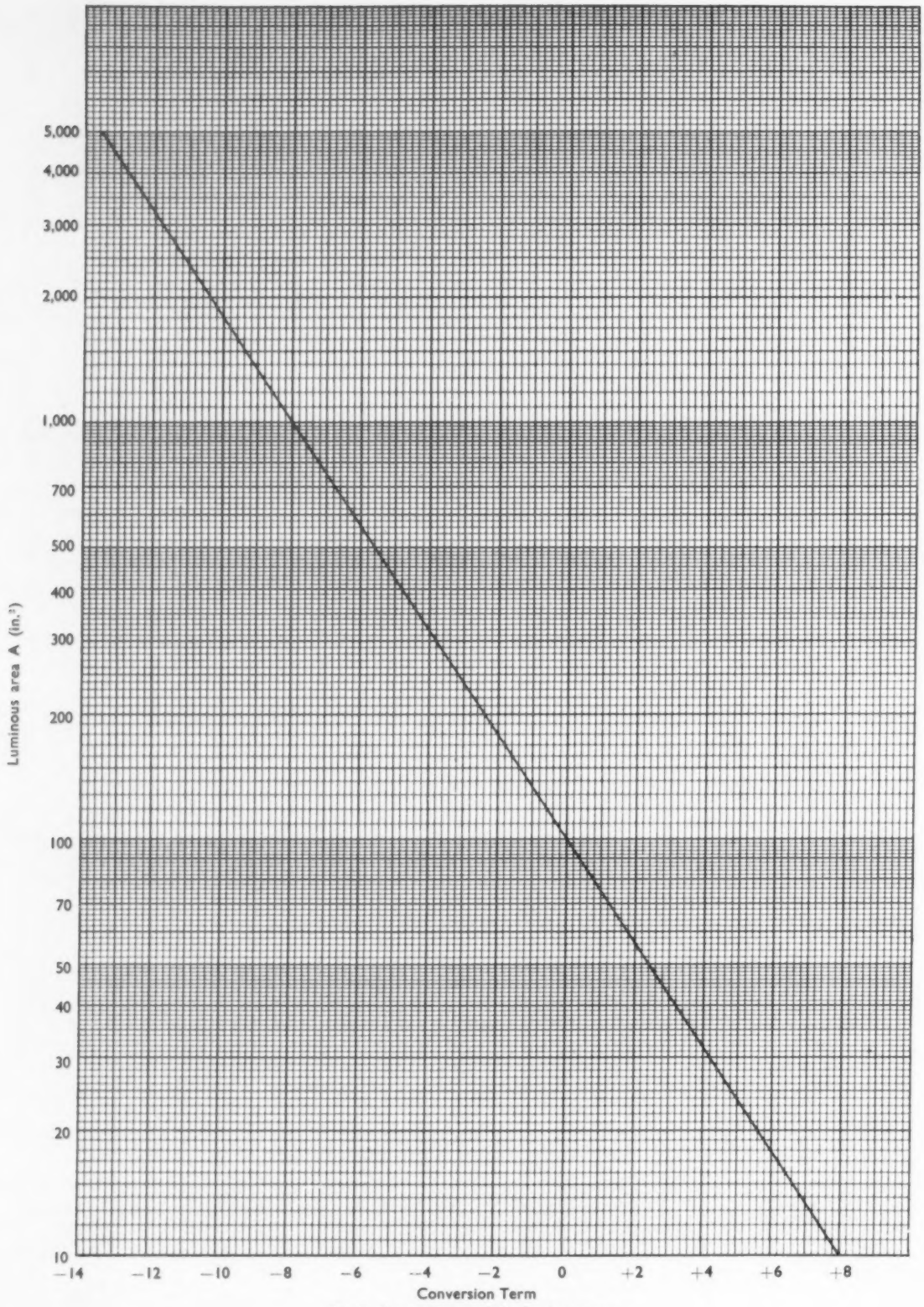

Fig. 2. Conversion graph for luminous area

(6) Why do the Conversion Terms for Height H in Table 4 increase with increasing mounting height when experience suggests that the discomfort glare will decrease?

The effect of increasing the mounting height cannot be obtained from Table 4 alone. The new conversion term must be taken in conjunction with a new Initial Glare Index obtained with reference to room dimensions recomputed in terms of the new value of H.

Example

Installation Data

Height H of fittings = 9 ft − 4 ft = 5 ft
Room Dimensions X = 60 ft = 12H
Y = 60 ft = 12H
Reflection Factors Ceiling 70%
Walls 50%
Floor 14%

Lighting Fitting Data

Opal Glass Fitting with 200w g.l.s. lamp
BZ Classification BZ 7
Upward Light Output Ratio 18% (Flux Fraction)
Downward Light Output Ratio 54% (Ratio = 0·33)

Downward Flux F = 54% × Lamp Flux
= 54% × 2720 lumens
= 1470 lumens
Luminous Area A = 150 sq in.

From Table 3.7
Initial Glare Index = 26·0
From Table 4
Conversion Terms
F (1470 lumens) = +1·0
A (150 sq in.) = −1·4
H (5 ft) = −0·8
Total −1·2
Final Glare Index = 26·0 − 1·2 = 24·8

If the mounting height of the fittings is now increased to 14 ft above the floor
Height H of fittings = 14 ft − 4 ft = 10 ft
Room Dimensions X = 60 ft = 6H
Y = 60 ft = 6H
From Table 3.7
Initial Glare Index = 22·2
From Table 4
Conversion Terms
F (1470 lumens) = +1·0
A (150 sq in.) = −1·4
H (10 ft) = 0·0
Total −0·4
Final Glare Index = 22·2 − 0·4 = 21·8

This example illustrates a decrease in the discomfort glare of 3 units on the Glare Index scale, when the mounting height of the fittings is increased from 9 ft to 14 ft.

In certain circumstances, of course, discomfort glare can increase with increasing mounting height. Generally, this occurs in installations of fittings having a definite 'cut-off angle', and the effect depends on its value relative to the room dimensions and mounting height.

This type of change can be illustrated by considering in the same installations as those used in the above example, a Deep Bowl Industrial Reflector with a 60° cut-off angle, and which has a BZ 3 classification. In this instance, when the mounting height is increased from 9 ft to 14 ft, the discomfort glare is increased by 0·4 units on the Glare Index scale.

(7) In what circumstances should the Conversion Terms for Linear Fittings (Endwise and Crosswise Viewing) be used?

These terms, published with Tables 3.4, 3.6, 3.7 and 3.8, should be used where the complete light distribution cannot be considered symmetrical, a marked difference occurring between the endwise and crosswise distributions. They should not be used, for example, for well-louvered fittings: a white metal trough reflector with white metal 'egg-crate' louvers for a fluorescent tube usually has a BZ 4 classification, but the terms should not be applied because the distribution can be considered symmetrical.

A further consideration in this matter is the fact that these published terms were calculated using light distributions in the endwise direction of cos θ (BZ 5) and in the crosswise direction, the type to give the required mean distribution. This, of course, explains the reason for the absence of these terms from Table 3.5 (BZ 5), the distribution being considered symmetrical.

The IES Technical Committee is at present calculating further conversion terms for use with linear fittings having endwise distributions which are not cos θ, e.g. a fitting for fluorescent tubes with luminous sides and a louvered bottom.

Interpolation between the published values of these conversion terms for room dimensions should be made on a linear basis.

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New facilities at the BRS

WORK ON BUILDING MATERIALS is one of the Building Research Station's oldest activities, but has hitherto been hampered by the scattering of laboratories in temporary structures over the site. It will now, however, be considerably assisted by a new materials research laboratory building, opened recently by Sir Harry Melville, KCB, FRS, Secretary of the Department of Scientific and Industrial Research. The new building not only provides considerably extended facilities for materials research but also makes possible much closer co-ordination between the different sections involved in this work.

The new laboratory forms part of the plan for the long-term development of the Station; further buildings expected to be erected in the next few years will be concerned with heating and ventilation, lighting, sound and acoustics, and engineering. Work in the laboratory covers all building materials except timber and ranges from fundamental laboratory research to pilot scale manufacture of building components such as perforated bricks, lightweight aggregate or similar products developed at the laboratory. The work demands a knowledge of the basic physical and chemical properties of the materials, the determination of which forms the broad category of activities to be carried out in the new building, and to this end much new apparatus (notably an electron microscope) has been installed.

The laboratory was designed and built by the Ministry of Works to meet the fundamental principle that maximum economic adaptability of services, partitions and fittings should be provided in working areas within the limits of the 40 in. planning grid adopted for the building and with which all main horizontal and vertical dimensions conform. The laboratories proper are situated on first, second and third floors and consist essentially of completely open spaces 200 ft by 36 ft 8 in., capable of subdivision by lightweight partitioning to any desired layout within the limits of the grid. The ground floor accommodates entrance hall and exhibition space, offices, engineering plant rooms and constant temperature chambers.

The site slopes towards one end of the building, of which advantage has been taken by providing a sub-ground floor at the lower end with direct access from the service road to stores and workshop. An important feature at this level is a service corridor running from the store to a lift at each end of the building, enabling 'dirty' materials to be raised to the particular laboratory requiring them without crossing other areas. Another feature of the building is that the grid gives a 13 ft 4 in. floor to floor height of which a 40 in. interfloor space is provided for services leaving a floor to ceiling height of 10 ft.

On each floor area, services are carried in a perimeter floor casing arranged beneath the windows, to which junctions are provided at set intervals, and these are supplemented by access holes in the pre-cast floor units. A good general standard of lighting has been achieved using largely Merchant Adventurers' 'Ventura' fittings changing in some areas to the same firm's 'MA1930' series. In all cases, the fixed wiring terminates at outlets on the structural ceiling, the actual connection to the fitting being effected by flexible cables.

Introducing IES Technical Report No. 2

DR J. W. T. WALSH EXAMINES OLD AND NEW METHODS OF CALCULATING COEFFICIENTS OF UTILISATION

Following the publication of its new lighting Code in April, the Illuminating Engineering Society has now issued its Technical Report No. 2, entitled 'The Calculation of Coefficients of Utilisation'. The Report has special significance for lighting engineers by introducing an important new method of calculation, the British Zonal Method, from which stems a new system of classifying lighting fittings in terms of their direct contribution to the light on the working plane. This classification not only simplifies the calculation of coefficients of utilisation but also forms the basis for the new IES Glare Index System. This review describes the new system, and shows how it differs from the original Harrison-Anderson method.

The Original Lumen Method

THE COEFFICIENT OF UTILISATION, hitherto usually termed in this country the utilisation factor, of a lighting installation is, quite simply, the efficiency of the installation in the strictly engineering sense and is expressed as that percentage of the luminous flux from the lamps which reaches the working plane.

The concept was introduced soon after developments in light sources early in this century had caused lighting engineers to divert their attention from the directional luminous intensity (or candle-power) to the non-directional luminous flux. In particular, Ward Harrison and E. A. Anderson in the USA carried out their well known experiments in model rooms on which was based the lumen method of lighting design.

Originally, the first step was to divide the flux from a fitting into three parts according to an ingenious plan. The polar curve of the fitting had superposed on it a circle, the polar curve of an ideal line source whose horizontal luminous intensity was equal to that of the fitting. This polar curve represented one of the three parts and it will be seen that when this was taken away the horizontal luminous intensity was zero and so the other two parts were respectively entirely upward flux and entirely downward flux.

The experiments gave weighting factors for each of the three flux components, these factors being functions of the room dimensions and of the reflection factors of the different surfaces. In this way it was possible to derive for any polar curve a coefficient of utilisation for any given room dimensions and any given values of the reflection factors.

As a natural development, tables were produced for each of a series of fittings with typical polar curves, each such table giving the coefficient of utilisation of the fitting for a range of room dimensions and reflection factors. These are the tables which have become so familiar to lighting engineers over the past few decades.

It is useful to bear in mind the underlying basis of the Harrison-Anderson method because the methods which have been proposed of late, and in particular the British Zonal Method described in the recently published Technical Report No. 2 of the IES, are in many respects similar in their conception. As pointed out in the Report, the original method suffered from certain defects, in particular as regards the way in which the downward component of flux was treated. The aim in introducing the new method is to improve the accuracy, especially in dealing with flux distributions which differ widely from those generally met with when the original method was being evolved. It is a modification of a method put forward in 1951 by J. R. Jones and J. J. Neidhart in the USA.

The British Zonal Method

In the method described in the IES Technical Report, the luminous flux reaching the working plane is divided into two components. The first is that derived, necessarily by reflection at wall and ceiling, from the flux emitted by the fittings in all directions above the horizontal, i.e. from the *upward flux*. The second is that derived, partly directly and partly by reflection, from the flux emitted by the fittings in all directions below the horizontal, i.e. from the *downward flux*.

The first component is the simplest to find. It is the upward flux (see Fig. 1) multiplied by a figure called the *upper flux utilance* which depends only on the geometry of the installation and the reflection factors of the room surfaces. This multiplier is exactly analogous to the utilisation factor for an indirect installation in the original lumen method, except that it is applied to the upward luminous flux from the *fittings* instead of to the total flux from the *lamps*.

The upper flux utilance is given in Table 4 of the Report for a number of combinations of reflection factors and for a range of values of *room index*. The room index is defined as

$$k_r = \frac{LW}{(L+W)H_m}$$

where L and W are respectively the length and width of the room and H_m is the mounting height of the fittings above the working plane.

There is an important departure from familiar practice which must be noted here. Except when the fittings are ceiling-mounted, the figures to be used for the reflection factor of the ceiling is not the actual reflection factor of that surface but a lower figure, R_e, called its *effective reflection factor*. R_e is equal to

$$\frac{A_c R_a}{A_c R_a + A_t(1-R_a)}$$

where A_c is the ceiling area on plan, A_t the total area of all the surfaces above the plane of the fittings, while R_a is the average reflection factor of these surfaces. (It will be seen that for a ceiling-mounted fitting $A_t = A_c$, so that $R_e = R_a$.) Table 2 in the Report gives values of R_e for a range of values of R_a and for different cavity indexes. The *cavity index* is, in effect, the room index for the space above the fittings, i.e. it is

$$\frac{LW}{(L+W)H_c}$$

where H_c is the distance of the fittings below the ceiling.

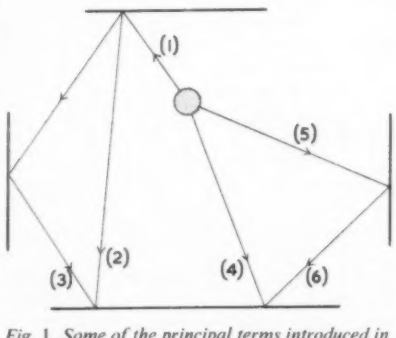

Fig. 1. Some of the principal terms introduced in the Technical Report: (1) is upward flux; [(2)+(3)]÷(1) is the upward flux utilance; (4)+(5) is the downward flux; (4)÷[(4)+(5)] is the direct ratio; [(4)+(6)]÷[(4)+(5)] is the lower flux utilance.

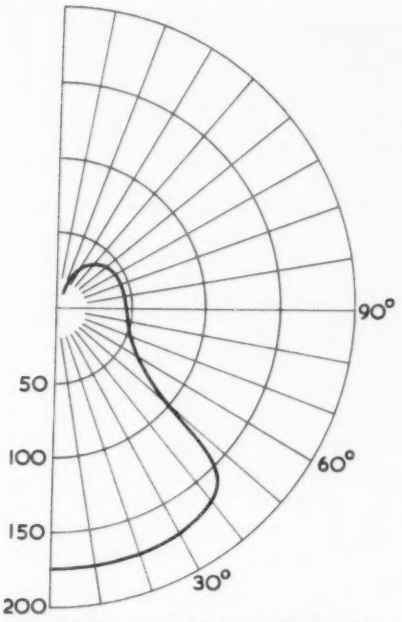

Fig. 2. Polar curve of light distribution for a hypothetical fitting used in the example given to show the method of calculation.

In finding the second component of the flux reaching the working plane the two parts (direct and reflected, [4] and [6] in Fig. 1) have first to be considered separately. It will be clear that the part received directly depends only on the light distribution from the fittings and the geometry of the installation, i.e. the dimensions of the room and the disposition of the fittings in it. If the polar curve of a fitting in the lower hemisphere is given and the relevant dimensions are known, it must be possible to calculate what fraction of the total downward flux reaches the working plane directly. This fraction is termed the *direct ratio*.

To simplify the calculation it is assumed that the fittings are arranged in square formation and Table 1 of the Report gives, for a series of spacing/height ratios (S/H_m where S is the spacing) and a range of room indexes, a set of nine *zonal multipliers*. The flux emitted by the fitting within each 10° zone of the lower hemisphere is multiplied by the appropriate zonal multiplier and the sum of the products is the flux incident directly on the working plane. The direct ratio, d, can then be found at once.

It will be clear that the other, indirect, part of the illumination component derived from the downward flux is proportional to $(1-d)$, the factor of proportionality depending on the room index and the various reflection factors. Thus, of the two parts making up this component, one is proportional to d while the other is a function of d, the room index and the reflection factors. It follows that the component as a whole is a function of these quantities and so, therefore, is the *lower flux utilance*, that fraction of the downward flux which reaches the working plane. Table 3 in the Report gives the lower flux utilance for a range of values of d and of the room index and the reflection factors of walls, floor and ceiling, the last-named being again the effective reflection factor calculated as explained earlier.

At this stage it may be helpful to summarise the procedure described above.

(1) Given the room index and the reflection factors (including the effective reflection factor of the ceiling), use Table 4 to find the upper flux utilance.

(2) Given the spacing/height ratio and the room index, use the appropriate zonal multipliers in Table 1 to calculate from the polar curve how many lumens reach the working plane directly. Express this figure as a fraction of the total flux emitted by a fitting in the lower hemisphere. This is the direct ratio, d.

(3) Given d, the room index and the reflection factors of the room surfaces, use Table 3 to find the lower flux utilance.

(4) Form two similar products, viz. (i) the upward flux emitted from a fitting, multiplied by the upper flux utilance and (ii) the downward flux from a fitting, multiplied by the lower flux utilance. The sum of the two products, divided by the total flux from the *lamp* is the coefficient of utilisation.

It is to be noted that the two values of flux required in (4) may be obtained directly from the polar curve, or they may be found from two figures provided by the manufacturer. These are the *upward light output ratio*, i.e. the upward flux from the fitting expressed as a fraction of the total flux from the lamp, and the *downward light output ratio*, which is similar.

Example

The simplicity of the calculations required in using the method described in the Report may best be demonstrated by means of an example worked in full.

A room 30 feet wide and 60 feet long is lit with fittings having the light distribution shown in Fig. 2, which is drawn for a lamp giving 1,000 lumens. They are mounted 8 ft above the working plane and 2 ft 6 in. below the ceiling. The spacing is 10 ft in both directions. The reflection factors of ceiling, walls and floor are respectively 80, 50 and 10%.

Since $L=60$, $W=30$, $S=10$ and $H_m=8$, the room index is

$$\frac{60\times30}{(60+30)8}=2\cdot5$$

and the spacing/height ratio

$$\frac{10}{8}=1\cdot25.$$

The direct ratio can now be found from the polar curve, using the zonal multipliers for spacing/height ratio 1·25 and room index 2·5 in Table 1. The Table at the foot of this page shows a convenient scheme for its calculation.

Thus the direct ratio is

$$\frac{403}{597}=0\cdot676.$$

The next step is to find the effective reflection factor of the ceiling. A_c, the area on plan, is 1,800 sq ft while the wall area above the fitting is $2(60+30)\times2\cdot5=450$ sq ft. Thus A_t, the total area of the surfaces above the fittings, is 2,250 sq ft and the average reflection factor R_a is

$$\frac{1{,}800\times0\cdot80+450\times0\cdot50}{2{,}250}=0\cdot74.$$

Therefore the effective reflection factor R_e is

$$\frac{1{,}800\times0\cdot74}{1{,}800\times0\cdot74+2{,}250\times0\cdot26}=0\cdot695$$

or practically 70%.

[Alternatively, the cavity index is

$$\frac{60\times30}{(60+30)2\cdot5}=8$$

and from Table 2 the corresponding value of R_e when $R_a=0\cdot74$ is found to be 70%.]

The lower flux utilance can now be found from Table 3. Since the wall reflection factor is 50%, section 3·1 of the Table is used and for a room index of 2·5 and $R_e=70\%$ the figures given for direct ratios of 0·6 and 0·7 are respectively 0·77 and 0·85 when the reflection factor of the floor is 10%. Thus the lower flux utilance for a direct ratio of 0·676 is 0·83. Since the total downward flux is 597 lm (see table above), the downward flux reaching the working plane is $597\times0\cdot83=496$ lm.

Convenient work scheme for obtaining direct ratio

Zone (degs)	Average cd.	Zone factor	lm in zone	Zonal multiplier	Direct flux
0–10°	175	0·095	17	1·0	17
10–20°	175	0·283	49	1·0	49
20–30°	173	0·463	80	1·0	80
30–40°	170	0·628	107	0·87	93
40–50°	150	0·774	116	0·72	83
50–60°	75	0·897	67	0·67	45
60–70°	57	0·993	56	0·52	29
70–80°	50	1·058	53	0·14	7
80–90°	48	1·091	52	0	0
		Downward flux	597	Direct flux	403

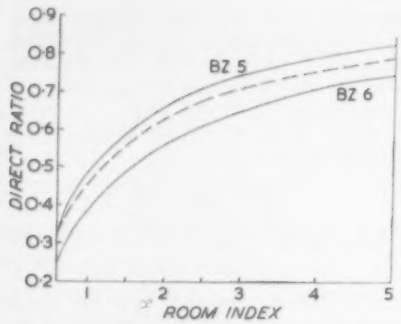

Fig. 3. Direct-ratio curve of the hypothetical fitting used in the example, with the curves of BZ 5 and BZ 6 fittings.

The total upward flux (found from the polar curve in the same way as the downward flux) is 249 lm and the upper flux utilance given in Table 4 for a room index of 2·5, R_e=70% and wall reflection factor 50% is 5·57, so that the upward flux reaching the working plane is 249×0·57=142 lm.

Thus the total flux reaching the working plane per 1,000 lm from the lamps is 496+142=638 and the coefficient of utilisation is therefore 0·64.

British Zonal Classification

It will be clear that from the polar curve representing a particular light distribution, the value of the direct ratio *d* can be calculated for any given values of room index and spacing/height ratio, assuming that the fittings are arranged in square formation. Thus if a spacing/height ratio appropriate to the particular distribution is assumed, it is possible to draw a single curve connecting *d* with the room index and this curve may be regarded as characteristic of the distribution.

This is the basis of the British Zonal Classification. Ten basic distributions, covering the range likely to be met with in practice, have been chosen and for each of them the direct-ratio curve, relating *d* to room index, has been drawn. The distributions are referred to by the designations BZ 1 to BZ 10 respectively and the curves are labelled similarly.

Any actual fitting may be classified on this system by drawing its direct-ratio curve from whatever spacing/height ratio is considered suitable. This curve is compared with the ten basic curves and the BZ number of that one which it most closely follows is the BZ number to be assigned to the fitting. As pointed out in the Report, this number may not be the same for all values of room index. It may, for instance, be a unit higher or lower when the room index exceeds a certain value.

The lower flux utilance for fittings of known BZ number can be found, without any calculation, from Table 7 in the Report. This Table is in ten parts, each referring to one BZ number and covering a range of room indexes and reflection factors. The upper flux utilance can be found from Table 4 (repeated in the Report as Table 8) because it is independent of the light distribution.

The coefficient of utilisation is now calculated as before, the only information required in addition to the BZ number being the upward and downward light output ratios (see above).

Again the example

It is instructive to apply this method to the installation considered earlier. The first step is to draw the direct-ratio curve for the distribution of Fig. 2, assuming a spacing/height ratio of 1·25. This is done by finding the direct ratio for a series of room indices, using the appropriate zonal multipliers and following the procedure indicated by the last two columns in the Table given earlier. The values found for the direct ratio are:

Room index	0·6	1·0	1·5	2·0
d	0·32	0·46	0·56	0·63
Room index	2·5	3·0	4·0	5·0
d	0·68	0·71	0·75	0·79

In Fig. 3 these values are represented by the broken line, while the two full lines represent respectively the curves BZ 5 and BZ 6 given in the Report. It will be seen that the number to be assigned to the fitting used is BZ 5, so section 5 of Table 7 is used and the lower flux utilance for a room index of 2·5 and the appropriate reflection factors is found to be 0·85.

The coefficient of utilisation is now calculated as before.

The small difference between the values of lower flux utilance found by the two methods indicates the kind of accuracy to be expected when the shorter method, based on the BZ number assigned to a fitting, is used.

At the end of the Report the hope is expressed that manufacturers will give the BZ numbers (as well as the two light output ratios) for their fittings because, quite apart from their usefulness for facilitating the calculation of coefficients of utilisation, they are essential for finding the glare indexes used in the new edition of the IES Code.

In conclusion it should be mentioned that the Report describes how to calculate the coefficient of utilisation for a luminous ceiling. It also gives guidance where the outer fittings in an installation are very close to the walls.

I E S TECHNICAL REPORT NO. 2

The calculation of coefficients of utilisation

This document introduces an important new method of calculating coefficients of utilisation. Known as the British Zonal Method, it is simple to use and gives the lighting engineer a degree of accuracy and flexibility not previously possible. It also offers a new method of classifying lighting fittings which makes possible further simplifications in calculation and forms the basis of the IES Glare Index System.

Price 10*s.* 6*d.*

THE I E S CODE 1961

Recommendations for good interior lighting

This publication marks a significant step forward in the design of lighting installations in that, for the first time, it introduces quantitative methods of assessing glare in projected lighting schemes. The Code also recommends a new approach to daylight design which recognises that in some buildings the permanent supplementary use of artificial light may be required. The schedule of recommended values of illumination has been extended and all values have been revised.

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LIGHTING ABSTRACTS

OPTICS AND PHOTOMETRY

1004. Retinal illumination and age. 612.843.3

R. A. WEALE, *Trans. Illum. Eng. Soc.* (*London*), **26**, 95–100 (No. 2, 1961).

Factors which bear on retinal illumination include the transmission of the cornea, the area of the pupil, the absorption and scatter of the crystalline lens, the colour of the vitreous humour and the optical density of the retinal pigment. Changes in each of these factors with age are discussed, photopic and scotopic conditions being separately considered. Using spectral distribution data for two CIE Standard Illuminants and for a number of fluorescent lamps, it was found that at the age of 60 the retinal illumination is only about one-third of its value at the age of 20, with very little difference due to spectral composition of the illuminant. It is felt that the older eye is served best by an accentuation in visual contrast. Where the level of illumination is increased, this should be by emphasis on the warmer radiations. P. P.

628.977

1005. Determination of illumination levels from Blackwell's investigations.

H.-J. HENTSCHEL, *Lichttechnik*, **13**, 256–260 (*May* 1961). *In German.*

Describes Blackwell's work on the determination of illumination values. One section of the paper is devoted to a criticism of that author's 'field factor'. It is pointed out that the component of the factor ascribed to observer experience is open to considerable uncertainty, while the assumptions of (*a*) a performance level of 99 per cent and (*b*) a standard rate of five assimilations per second may not be appropriate under all conditions. If the factor is reduced from 15 to 12 or 10 the effect on the illumination value obtained may be very great, especially at the higher values of luminance. It is concluded that more research is necessary (*Note*: The diagrams of Figs. 3 and 5 have been interchanged.) J. W. T. W.

1006. Digital recording illumination photometer. 535.247.4

W. GRÜNDLER, *Lichttechnik*, **13**, 261–262 (*May* 1961). *In German.*

A cosine- and colour-corrected photovoltaic cell is connected in a circuit such as the Campbell-Freeth circuit so that the external resistance is effectively zero and the photocurrent therefore proportional to the illumination. This current is fed into a digital recorder designed to indicate values up to 1,000 lux in steps of 1 lux. Values within this range can be recorded at the rate of two per minute. J. W. T. W.

LAMPS AND FITTINGS

1007. New fittings for the home. 621.329

Ljuskultur, **33**, 48–50 (No. 1, January–March 1961). *In Swedish.*

Describes with illustrations the recent designs of home lighting fittings advanced by Swedish manufacturers. Coloured lacquered or anodised metal is much in evidence. Glass of different diffusing or decorative character is still widely used in spite of the good qualities of plastic materials. R. G. H.

1008. Interflections in aperture lamps. 621.327.43

D. E. SPENCER and L. L. MONTGOMERY, *Illum. Engng.*, **56**, 231–238 (*March* 1961, *Section* 2).

Fluorescent lamps of very high luminance can be obtained by using reflector-coated lamps with an aperture of only about 30° angular size cut through both the reflector and phosphor coatings. A mathematical analysis of the interreflection processes in these lamps is given from which it is shown that with reflector coatings of high reflectivity, the resultant aperture luminances are critically dependent on small variations in the coating reflectivity. A family of reflectors are described which employ aperture lamps to give a sharp top cut-off, and beam widths from a fraction of a degree up to 60°. P. P.

621.329

1009. Design and performance of an inset runway light.

C. H. LOCH, *Illum. Engng.*, **56**, 241–244 (*March* 1961, *Section* 2).

Aircraft signal lights in the touchdown area, along the runway centre-line and into the taxying areas must be designed for easy installation in the runway surface, must have the extremely low beam angle and high candlepower necessary for adequate visibility by the pilots and must withstand the tremendous impact from aircraft landing wheels. Other hazards are extremes of weather, snowploughs, jet exhausts and aircraft tailhooks. A bi-directional fitting to meet these requirements is described having an overall depth of $1\frac{1}{8}$ in. and projecting $\frac{1}{8}$ in. above the runway surface. Candlepower characteristics for such a fitting using a 45w lamp are given. P. P.

621.327.43

1010. Design and characteristics of aperture fluorescent lamps.

C. L. TOOMEY, *Illum. Engng.*, **56**, 227–230 (*March* 1961, *Section* 2).

Because of interreflections, the luminance of the inside surface of the phosphor coating of a fluorescent lamp is greater than the luminance of the exposed surface. This can be taken advantage of by cutting an aperture in the coating through which to view the inside surface. Furthermore, the interior luminance can be increased by using a titanium dioxide reflector coating between the phosphor and the lamp wall. By using an aperture of 30° angular size, luminances as high as 24,000 ft-L have been obtained with very high output lamps. The narrow beam width and high beam candlepower means that aperture lamps lend themselves to use with fittings having precise optical control. P. P.

1011. 40-watt fluorescent lamp with higher light output. 621.327.43

D. D. HINMAN and R. S. FOX, *Illum. Engng.*, **56**, 222–225 (*March* 1961, *Section* 2).

Of the energy input to a conventional 40w fluorescent lamp, about one-third is dissipated in the filling gas and at the electrodes. By attention to the filling gas pressure and composition and to the size of the electrodes, an overall increase of 5 per cent in lumens and lumens per watt has been obtained, regardless of any increase which can be achieved from the use of improved phosphors. In particular the filling gas pressure has been reduced to 2·5 mm, a 30 per cent : 70 per cent mixture of neon/argon has been used for the filling gas and the anode area has been increased to 5 cm². P. P.

LIGHTING

1012. Colour of high pressure mercury lamps. 621.327.4

C. W. JEROME, *Illum. Engng.*, **56**, 209–213 (*March* 1961, *Section* 2).

The change in colour appearance of a mercury discharge lamp with increase in mercury vapour pressure is illustrated by comparative spectral distributions and by a continuous line drawn on a CIE chromaticity diagram. The effects of phosphor coatings and of additional colour filters to meet certain design requirements such as better colour rendering or increased lumen output are also illustrated by means of spectral distribution curves, the CIE diagram and chromaticity co-ordinates. P. P.

621.327.4

1013. How operating position and circuit variations affect mercury lamp characteristics.

H. D. FRASER, W. M. WALDBAUER, M. C. UNGLERT and J. A. WALICK, *Illum. Engng.*, **56**, 215–219 (*March* 1961, *Section* 2).

When a mercury vapour lamp is burnt in a horizontal position, both the lamp wattage and lumen output are reduced below the corresponding vertical position values. The explanation arises from increased cooling of the discharge due to a bowing in the arc towards the lower temperature quartz wall in the horizontal position. The deficiency can be compensated for by an increase in power dissipation in the arc either to maintain the wattage or the lumen output unchanged. The performance of 400w lamps operated from reactor, auto transformer and regulated output circuits is considered in relation to variations from rated supply voltage. P. P.

1014. Lighting the work and its environment. 628.972
A. LIPPESTAD, *Ljuskultur*, **33**, 35–42 (No. 1, *January–March* 1961). *In Norwegian.*

The lighting of workplaces is concerned both with the illumination on the work for visual efficiency, and with the lighting of the environment to inspire and stimulate as well as to create comfortable surroundings conducive to satisfaction. The cost of good quality lighting is discussed. Daylight varies in quantity and in colour throughout the day, and individually controllable blinds should be provided to minimise these effects. Glare can be mitigated by choice of light wall surfaces, which should not be glossy. Fuorescent lighting still has to overcome the prejudice—'never in *my* building'—but the windmill beat Don Quixote in the end. R. G. H.

628.972
1015. Can one distinguish between filament and fluorescent lighting?
Ljuskultur, **33**, 8 (No. 1, *January–March* 1961). *In Swedish.*

An experiment was undertaken with 124 observers asked to judge whether the illumination on a scene was by de luxe white fluorescent or by filament lighting. For the tests the scene consisted of a red-headed girl in a green skirt, or alternatively a black-haired girl in a blue skirt, seen against a background of multi-coloured draperies beside a table on which was a bowl of fruit and a bunch of flowers. Each observer was given five opportunities to make a judgment. The results indicated that the two sources could not be distinguished without great difficulty. Only 8 out of 124 obtained 5 correct answers, and 12 were wrong every time.
R. G. H.

1016. Street lighting. 628.971.6
L. STARBY, *Ljuskultur*, **33**, 9–13 (No. 1, *January–March* 1961). *In Swedish.*

The efficiency of a street-lighting system can only be assessed in terms of a number of different factors, of which the most important are level of illumination on the road surface, the luminance of the surface as seen by the driver, the uniformity of luminance, glare, and visibility. Subjective assessments of the three latter factors are essential. Methods of obtaining these assessments and the scales used are discussed, and it is claimed that these subjective assessments demonstrate that for equal overall subjective efficiency the mean luminance of the road can be from 30 to 50 per cent lower with sodium than with mercury light.
R. G. H.

1017. Bleaching and heating effects. 628.972
G. SILJEHOLM, *Ljustultur*, **33**, 53–54 (No. 1, *January–March* 1961). *In Swedish.*

The effect of ambient temperature on the bleaching properties of light at different levels of illumination is discussed. The transmission of window glass to u.v. is given and reference made to special glasses of low transmission. The radiation of fluorescent tubes contains a much smaller proportion in the ultra-violet band than does daylight. R. G. H.

1018. Should the schedules of illumination level be revised? 628.93
G. HASSEL, *Ljuskultur*, **33**, 21–28 (No. 1, *January–March* 1961). *In Swedish.*

The relation between illumination and various visual factors such as speed of seeing, certainty of seeing, contrast sensitivity and visual activity is discussed in relation to the recent work of Blackwell in the USA and the new proposals of Weston in England. Comparison is made between current Swedish recommendations for illumination level and the new USA values, the difference being approx. 1:3 for coarse visual work and 1:10 for fine work. A brief mention is made of the Russian recommendations. The effect of age is to require more light, partly due to the yellowing of the lens, and in view of the rising average age of workers, this should be taken into account. Much more 'fine' work has to be done, at a higher speed and accuracy. All these factors point to a revision upwards of the recommended levels of illumination.
R. G. H.

1019. Cove lighting in a library. 628.972
M. G. TALBOT, *Illum. Engng.*, **56**, 247–249 (*April* 1961).

Where ceiling heights vary or the roof is of shallow construction, cove lighting is being increasingly used as a general lighting system. The library of the Pacific High School in San Leandro, California, is a recent example. The 60-ft diameter parabolic ceiling is lit by three-lamp 8-ft industrial fluorescent fittings directed on to the ceiling from the tops of the book racks. The design illumination of 70 lm/ft² was achieved using a calculation procedure derived from a formula originally proposed by R. E. Burnham in 1950. P. P.

1020. Europe's streets and highways. 628.971.6
J. W. YOUNG, *Illum. Engng.*, **56**, 253–261 (*April* 1961).

Trends in the use of light sources, lighting fittings, methods of mounting or suspension and illumination characteristics are reviewed in respect of present-day street lighting in a number of European countries. Mercury, sodium and fluorescent lamps all have their application, with several installations using xenon arcs. Attention is given not merely to illumination level but also to control of glare and luminance distribution on the roadway. The article is illustrated with photographs of a number of British and Continental street-lighting installations. P. P.

1021. Visual problems on motorways. 612.843.3: 628.971.6
J. M. WALDRAM, *Trans. Illum. Eng. Soc. (London)*, **26**, 66–75 (No. 2, 1961).

The visual problems of driving in traffic routes, and on motorways under day and night conditions, have been studied by means of tape recordings of drivers' reactions and accompanying cinematograph records. The meagre and often misleading amount of visual information received when night driving on motorways is particularly emphasised. The study, linked with observations of the driving conditions on lighted Continental motorways, leads to a conclusion that a technical case can be made out for the lighting of motorways. The characteristics of such lighting is discussed. An appendix offers suggestions for the improvement of guidance and car signal lights. P. P.

1022. Lighting and research. 612.84
W. S. STILES, *Trans. Illum. Eng. Soc. (London)*, **26**, 53–65 (No. 2, 1961).

The research background to lighting is considered in respect of the development of new light sources and the study of the nature of the visual process. Physics and chemistry have contributed largely to research into gas-discharge lamps and into the conjunction of solid phosphors with the discharge source (the fluorescent lamp). The development of new sources has brought with it the need to specify not only the quantity of light but also the colour and colour-rendering properties of a light source. Visual research is concerned with both the structure and functions of the perceiving organism and the response of the intact organism to a light stimulus. In the first category, the electron microscope has facilitated the detailed study of the structure of the retinal rods and cones. Other aspects to be extensively investigated include the detection and identification of visual pigments, the effect of light stimuli on nerve impulses and the determination of involuntary eye movements. In the second category, the capacity of the visual mechanism, generally of the human subject, in respect of acuity, contrast sensitivity, colour discrimination, critical flicker frequency, discomfort and disability glare, etc., has been studied by specialist physiologists, psychophysicists and psychologists in the laboratories of the lamp industry and of certain Government departments. P. P.

1023. 25 years of stage lighting equipment. 628.978
F. P. BENTHAM, *Trans. Illum. Soc. (London)*, **26**, 79–92 (No. 2, 1961).

Stage-lighting equipment and techniques have been considerably influenced by the different ways in which theatres are organised in this country, the USA and Germany and in the different forms of stage presentation prevailing, including that of the 'progressive' theatres. Lighting equipment is considered in terms of spotlights, follow spots, effects projectors, scene projection, floodlighting, profile spotlights, acting area lanterns, Fresnel spots and the American PAR lamps. A plea is made for a rationalisation in the design of the existing very large range of lanterns. No sensational change in theatre lighting units is foreseen, the theatre proving a disappointment for the application of fluorescent lamps. P. P.

NEW PRODUCTS

Plant irradiation

INTENDED PRIMARILY for research organisations, a new plant irradiator fitting using a 400w fluorescent bulb mercury reflector lamp has been introduced recently by the Simplex Dairy Equipment Co designed to give a high level of illumination for encouraging good vegetative growth in a variety of plants. Experiments carried out on commercial crops, however, have given such promising results that the fitting seems likely to gain acceptance for commercial as well as research use. The unit comprises a ventilated protective housing in spun aluminium with hook for chain suspension. The lamp used is of the bowl-silvered type, with a bulb of specially designed contour; the phosphor used provides a 5·5 per cent red content of colour correction. For a minimum installation of three fittings placed at 4 ft centres over a 4 ft wide bench, the illumination along the centre of the bench is estimated at 1,000, 600 and 400 lm/ft² at mounting heights of 2 ft, 3ft and 4ft respectively.

The Simplex Dairy Equipment Co Ltd, Sawston, Cambridge.

New tungsten fittings

DETAILS HAVE JUST BEEN ANNOUNCED by Courtney, Pope of three new lighting fittings for tungsten lamps, forming part of a larger number of fittings for both tungsten and fluorescent lamps in course of completion. One of the fittings is the spot-lighting unit illustrated; it is designed for use with a 100w bowl-silvered lamp or a 150w 'K' lamp and comprises a metal spinning, 11⅛ in. diameter and recessed 8¼ in., which carries an adjustable reflector of super-purity aluminium.

A pendant fitting illustrates that the cylindrical form is still in vogue; it has an opal diffusing glass bowl provided with a decorative surround of a cylinder of square-mesh metal. The fitting is designed for use with 150w pearl lamps; its maximum diameter is 11 in. and overall depth 12 in. The third design is a ceiling mounted unit, in which a metal cylinder supports a square metal surround carrying a dish-shaped diffuser. These designs are illustrated in two new leaflets (101 and 102) which relate to 130 fittings being introduced.

Courtney, Pope (Electrical) Ltd, Amhurst Park Works, Tottenham, London N15.

Luminous ceiling panels

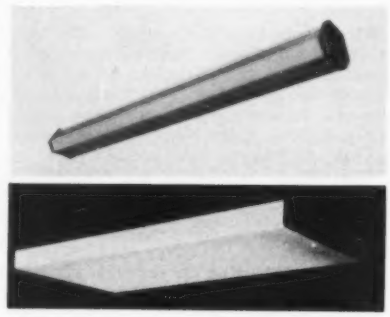
A NEW VENTURE FOR Knightshades Ltd is a luminous ceiling panel. Known as 'Knightsky', it is of the form of a thin plastics sheet stretched across a metal frame; what appears novel is that the panels can be supplied in shapes other than square (provided they are simple) and in any size up to 10 ft². The panels are normally supplied in translucent white but are also available in various pastel shades and for display purposes they may be printed or hand painted with individual decorative effects. Prices of the panels vary, of course, according to size, but for simple shapes the average price is about 5*s*. 9*d*. per ft².

Knightshades Ltd, Theaklen Drive, St Leonards, Sussex.

For the store

A GOOD EXAMPLE OF THE clean simple appearance of modern fluorescent lighting fittings for commercial application is provided by a new unit for four 80w lamps recently introduced by GEC. It comprises a rectangular diffuser in 040 'Perspex', with black ends in p.v.c., carried on a metal gear tray comprising two identical members joined by transverse bridge pieces. The switchless gear is mounted within the fittings, mains connection being effected by means of two fused terminal blocks, one to each pair of lamps. The p.v.c. end pieces are integral with the diffuser, which is therefore lifted off in one piece for cleaning and access to the interior. Although suitable only for pendant mounting it can be hung within 4 in. of the ceiling (the minimum distance necessary for removing the diffuser) to give the appearance of ceiling mounting.

The General Electric Co Ltd, Magnet House, Kingsway, London WC2.



Upper illustration shows one of the new Crompton Parkinson diffuser fittings based on their 'New Range' series; lower illustration is of the GEC's store lighting unit for four 80w lamps.

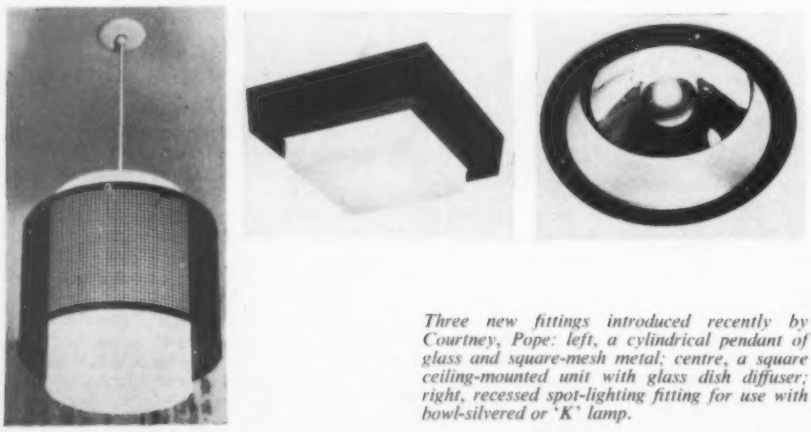
'New Range' Diffusers

A NEW SERIES OF totally enclosed diffusers of attractive design is now available from Crompton Parkinson. Suitable for use in shops, stores and offices, the new fittings are based on their 'New Range' 4 ft and 5 ft general purpose fittings, to which dished end plates (available in a choice of red, cerulean blue and primrose 'Permawhite' enamel finish) have been attached. The diffuser, of reeded opal plastic, is then sprung into position.

Crompton, Parkinson Ltd, Crompton House, Aldwych, London WC2.

Lighting Hose

BY ONE OF THOSE CHANCES which characterise many industrial developments, a firm noted primarily for the manufacture of hosepipe has produced an interesting new light diffusing material. The development was the result of research into high density polyethylene as a new material for hoses and it takes the form of a rigid translucent tube which provides good light diffusion. Being corrugated, the tube has an intrinsically attractive appearance and it can also be supplied in almost any pastel colour. It is available at present in bore sizes of 2 in. and 4 in. but the possibility of producing bores up to 12 in. is being investigated and ways are also being sought to produce cross-sections other than circular. It is made, as standard, in lengths up to 15 ft, but these can be exceeded if required; being rigid, it is self-supporting and is thus suitable for use as a free-



Three new fittings introduced recently by Courtney, Pope: left, a cylindrical pendant of glass and square-mesh metal; centre, a square ceiling-mounted unit with glass dish diffuser; right, recessed spot-lighting fitting for use with bowl-silvered or 'K' lamp.

standing unit for domestic application. Another advantage of the material is high impact and anti-crush strength and it can therefore be used in situations where more conventional materials would be likely to suffer damage, whilst steel wire reinforcement may be incorporated if necessary.
Recon (Pipelines) Ltd, Sheerwater, Woking, Surrey.

Fittings for high-output lamps

THE AMERICAN WESTINGHOUSE 'high-output' fluorescent lamp is featured in a new range of fittings now available from Troughton and Young. These lamps, which were shown, it may be recalled, at the Electrical Engineers' Exhibition earlier this year, are 8 ft, 110w with an average-through-life efficiency of 72 lm/w in the warm white and 3,500°K colours and a life varying from 7,500 to 18,000 hours depending upon the frequency of starting. The fittings consist of a twin-lamp batten unit to which diffuser and open-end reflectors are added. Parallel with this introduction is the extension of their 'Tubalux' range of fittings by a series of slim section fittings in both single and twin lamp versions. The fittings, which are suitable for pendant or ceiling mounting either singly or in continuous runs, are supplied in 2 ft, 4 ft and 5 ft sizes in the twin version and in 4 ft and 5 ft sizes in the single lamp versions.
Troughton and Young (Lighting) Ltd, 143 Knightsbridge, London SW1.

Starterless 'Popular Pack'

SWITCHLESS-START VERSIONS OF THE 'Popular Pack' series of fluorescent fittings, made by both Atlas and Ekco, are now being produced. Known as the 'Slickstart', the fittings are only a few shillings more expensive than their starter switch counterparts (which will continue to be available at the same prices at present), are outwardly similar in appearance and retain all the features of the standard type.
Atlas Lighting Ltd, Thorn House, Upper St Martin's Lane, London WC2.
Ekco-Ensign Electric Ltd, 45 Essex Street, Strand, London WC2.

Glass-fibre insulated flexible

BICC ANNOUNCE the availability of a new flexible cable insulated with glass-fibre and suitable for use at up to 250v as a lighting fitting connection. An addition to their existing range of miscellaneous cables, the new product is specially designed to function at the high temperatures likely to be encountered in many modern lighting fittings used for the lighting of office blocks, large stores and in enclosed show cases. In its natural state, the glass fibre, which has been treated with an appropriate varnish binder and filler, will not burn or carry flame and will remain intact when subjected to external temperatures up to 180°C.
British Insulated Callender's Cables Ltd, 21 Bloomsbury Street, London WC1.

Trade Literature

CROMPTON PARKINSON LTD, Crompton House, Aldwych, London WC2. New catalogue providing comprehensive reference for commercial and display lighting equipment for tungsten and fluorescent lamps. Two subsequent leaflets deal with the firm's high wattage filament lamps and new 'Crompack' fittings.

STRAND ELECTRIC AND ENGINEERING CO LTD, 29 King Street, London WC2. In 'Stage Planning 1961', Strand Electric have brought up to date the wealth of information it provides for those planning new stages in schools and communal buildings.

SIMPLEX ELECTRIC CO LTD, Creda Works, Blythe Bridge, PO Box No. 5, Stoke-on-Trent, Staffs. Concise list of Simplex lighting equipment is provided in a new catalogue, divided into sections according to type and application, for quick reference. Flameproof equipment is dealt with separately in a leaflet covering the firm's f.l.p. electrical equipment.

KNIGHTSHADES LTD, Silverhill Works, Theaklen Drive, St Leonards, Sussex. Distinctive feature of the firm's new catalogue is the reproduction in colour throughout, giving a good idea of the appearance of the fittings and facilitating their selection.

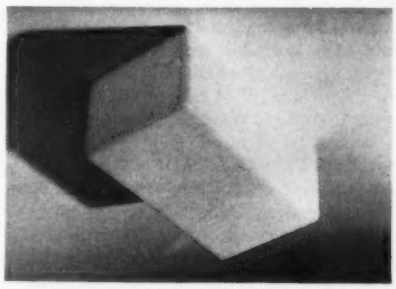
CLARKE, CHAPMAN AND CO LTD, Victoria Works, Gateshead 8, Co Durham. Industrial lighting equipment is described in a new catalogue giving examples of the wide variety of engineering products made.

FALK, STADELMANN AND CO LTD, 91 Farringdon Road, London EC1. Catalogue No. 815 describes Falks modern range of tungsten fittings, showing a number of new designs, some of which have been accepted by the COID.

COID Design Index

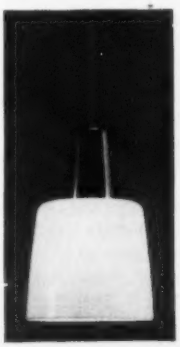
The following products have recently been accepted by the Council of Industrial Design for inclusion in its Design Index.

Frederick Thomas and Co



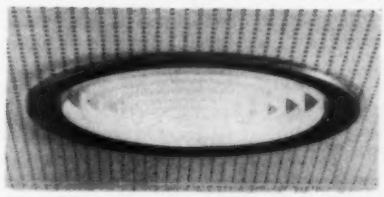
Ceiling-mounted fitting, No. SF 15642, designed by the firm's design office in collaboration with Oscar Faber and Partners. Constructed in rust-proofed steel and opal 'Perspex'; two sizes, for 60w and 100w lamps (or miniature fluorescent lamps); also semi-recessed version. Frederick Thomas and Co Ltd, Everton Buildings, Stanhope Street, London, NW1.

X-Lon Products



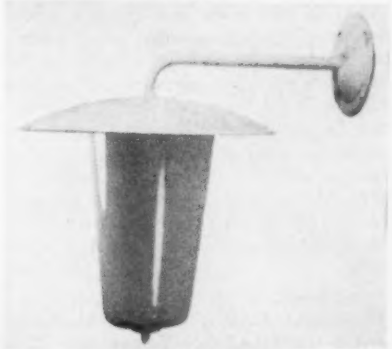
Pendant fitting model 107, made from acrylic sheet and brass attachments; ceiling canopy available. X-Lon Products, 48 Gillingham Street, London, SW1.

Merchant Adventurers



Ceiling fitting MA 1938, the 200w size in a series designed by Paul Boissevain. Louver is white opal, moulded in urea formaldehyde; reflector anodised aluminium in choice of satin silver or pale gold. The Merchant Adventurers Ltd, Hanworth Estate, Hampton Road West, Feltham, Middlesex.

Satchwell and Gittings



Weatherproof wall bracket, model Y.10, for 100w lamp; white opal glass bowl, metal reflector underside finished white, top side available in choice of colours. Satchwell and Gittings Ltd, Tantarra Electrical Works, Walsall, Staffs.

MISCELLANY

Book Reviews

'The Eye and its Function' by R. A. Weale, Ph D,D Sc; published by the Hatton Press, London, 1961; pp.209, price 55s.

The functions of vision are discharged with more or less success and satisfaction according to the available conditions of lighting. There is no point in contriving (i.e. 'engineering') the latter except to facilitate or impede the former, and some knowledge of the eye and its function is indispensable to all who essay a scientific approach to problems of lighting. Not all of Dr Weale's book *need* be known by those who major concern is with lighting, although all of it may well interest them. It begins at the beginning—with the embryological development of the eye—and this is followed by a chapter on the nutrition of the eye. Chapter 3 deals with the first stage in the process of seeing, which is the absorption of light by the visual pigments contained in the retinal receptors: then the process is followed through the visual pathways from the eyes to the seeing brain. Chapter 5 is concerned with the formation of retinal images as well as with visual acuity and its dependence on retinal illumination, wave-length of light and minute eye movements. Chapters 6 to 8 deal in more detail with the stimulation of the eye and the responses excited, which lead to perceptions of brightness, colour, brightness and colour differential sensitivity and flicker. The results of recent researches—a number of them those of Dr Weale himself—are embodied in these chapters. The next chapter deals with the eyes' muscular mechanism, without which vision would be impossible. The last three chapters are concerned with binocular vision, the natural provisions for protecting the eyes, and the effects of certain drugs. The author draws attention to the difference in spectral sensitivity of the fovea and the non-foveal regions of the light-adapted retina. Lighting standards, he says, are applied for the retina as a whole, yet they are based on data relating to the fovea. He shows, however, that the sensitivity of the retinal region at a perimetric angle of 25 deg. is maximal for light of 450 mμ wavelength instead of about 555 mμ as at the fovea. This seems to be relevant to the occasional extra-foveal perception of end-flicker from fluorescent tubes. H. C. W.

'Fluorescent Lighting Manual' by C. L. Amick; published by McGraw-Hill, New York, third edition, 1961; pp. xi, 400, 9 in. by 6 in., price 97s.

This book has been thoroughly revised to take account of the many advances in fluorescent lamps and lighting techniques which have taken place since the second edition was published in 1947. It is now crammed with up-to-date information which, although based on American practice, will still be of considerable value to engineers and technicians in this country. Its content and presentation combine to make it an indispensable *vade mecum* of fluorescent lighting practice.

Its opening chapters deal with various types of tubular fluorescent lamp (which for completeness includes electroluminescent light sources), auxiliary equipment and the operating characteristics of complete lamp circuits under normal and special conditions. The theme then switches to lamp installation and servicing, bringing out the responsibilities of contractors as well as designers in achieving correct operation of the installation, before going on to discuss luminaire selection and the illumination designer's need to equate functional efficiency with pleasing appearance and minimum visual discomfort. Drawing upon a wealth of practical experience, the author deals with the variety of factors affecting the design of diffusers, reflectors and luminous ceilings.

Practising engineers who plan their schemes on the lumen method of design will welcome the inclusion of co-efficients of utilisation for 72 different types of fitting. The importance of predetermined visual comfort is now recognised and formulae and tabular data are given to facilitate the computation of glare factors (not to be confused with British IES Glare Index System); there is also a useful chapter on colour quality. A single chapter only is given to applications and whilst this makes it impossible to cover every aspect, there is a helpful summary of the fundamental principles of installation design and the relationship between lighting and such other aspects of the environment as acoustics and air conditioning. General solutions are given to the basic lighting problems of various commercial, industrial and domestic interiors and there is a photographic review of modern installations although this would have been improved by diagramatic details of the equipment used. Finally comes a chapter on lighting economics, whose objective method of comprehensive cost computation warrants reference by all who wish to obtain the most for their 'lighting dollar'. J. B. H.

Personal

After serving 28 years with various AEI companies, Mr W. T. SAVAGE has joined the Head Office Sales Staff of The Benjamin Electric Ltd.

Chairman of the Electric Lamp Industry Council for the ensuing year is Mr J. CLEMENT of the AEI Lamp and Lighting Co. Mr Clement, who has been intimately connected with the industry since 1956, is also a vice-chairman of the BLC.

Following the recent death of Mr. E. G. FRYER, the AEI Lamp and Lighting Co have appointed Mr W. G. CREASY as acting manager of their Preston and Trent Vale g.l.s. lamp factories. He will be based at Preston, where previously he was superintendent, in which position he is succeeded by Mr W. G. ASHWORTH.

Merchant Adventurers Ltd have appointed Mr M. F. SILLETT as their UK sales manager. Having had eleven years' experience in the lighting industry, he joined the company as personal assistant to the sales director, having been previously manager of the GEC lighting department at Leeds.

As a further stage in the organisation of the expansion of its lighting and heating business, five new appointments are announced by the GEC's Lighting and Heating Group. Mr C. DYKES BROWN becomes the Group technical manager, in which position he will be responsible for the development of major project business and have functional responsibility for all the Group's technical sales specialists. Mr G. GALLETLY has joined the Group as marketing manager with overall responsibilities for distribution, sales planning, publicity and home sales. Mr R. E. REUBERSON is appointed home sales manager and Mr C. F. PERKINS distribution manager, whilst Mr G. F. COLE becomes publicity and sales promotion manager.

Several changes have been made by Holophane in their sales engineering representation: Mr S. E. HARRIS, for many years a senior lighting engineer, has been appointed to special sales engineering duties in the London area; Mr G. D. DEACON has moved from the East Midlands to a territory in the home counties where he will operate as sales engineer; he is succeeded in his former territory by Mr W. B. VALENTINE, who joins the company from Boots.

Mr R. MONERY has been appointed a technical director of Courtney, Pope (Electrical), having successfully held a number of positions in various departments in the firm, being at present responsible for its ceilings division.

The Sheffield area superintendent of the AEI Lamp and Lighting Co, Mr W. G. THOMPSON, has retired after more than fifty years' service with the company. He is succeeded by Mr E. MADDERS, who has been senior lighting engineer at Sheffield for the past five years. American born, Mr Thompson is a past chairman of the IES Sheffield Centre and has also been active in other organisations in the area. He started his career at 14 with British Westinghouse, being appointed superintendent of the Sheffield office of Metro-Vick in 1934.

Mr J. P. ENGELS has been appointed managing director of Philips Electrical Ltd in

succession to Mr G. F. HOFMAN, who has retired after more than forty years' service with the organisation.

The Homeshade Co announce that Mr S. GLASS, who recently joined them, has been appointed general manager of their new showrooms in Manchester,

Obituary

Ernest Gladstone Fryer

The death occurred suddenly in June of Mr E. G. Fryer, Manager of AEI's Preston and Trent Vale lamp factories. Aged 63, he was taken ill suddenly at work on June 12 and died at the Leicester Royal Infirmary two days later. From a training at Loughborough College, Mr Fryer joined BTH as a technical assistant in the Rugby lamp factory, being made efficiency engineer in 1940 and appointed general superintendent of the Rugby and Trent Vale factories ten years later. Mr Fryer was held in high esteem by his colleagues and the workpeople under his control; he leaves a wife to whom readers will join with us in extending our sympathy on her sad loss.

Overseas News

THE AMERICAN IES has changed its address. As from the beginning of this month, the Society's headquarters are now at 345 East 47th St, at United Nations Plaza, New York 17, N.Y., in the new United Engineering Centre there.

UNDER THE TRADE AGREEMENT signed between Hungary and Ghana in April, Barclays Bank DCO reports from Accra that a Hungarian company, the United Incandescent Lamp and Electrical Co, is to set up a lamp factory in Ghana. The factory will be capable of producing three million gas-filled filament lamps annually, one million fluorescent lamps and one million lamps for automobile and decorative use.

ELECTROLUMINESCENT light sources continue to excite interest in the USA. Westinghouse have expanded their production facilities and are now able to produce their 'Rayescent' panels in metal, as well as glass and plastics. Sylvania claim to have produced the world's largest electroluminescent 'lamp', a panel 8 ft by 2 ft having a surface luminance, when normally energised, of 5 ft-L. Another development, made by General Telephone and Electronics Laboratories (the research subsidiary of the General Telephone and Electronic Corporation, which firm also owns Sylvania), consists of a display device combining electroluminescence with the piezoelectric effect. The device comprises a sheet of piezoelectric ceramic, one surface of which is coated with a layer of electroluminescent phosphor. Voltage impulses applied to the ceramic induce acoustic waves in it, and electric fields associated with these waves react with the electroluminescent layer to produce spots of light. The position of the spots may be controlled by varying the timing of the impulses applied to the ceramic and their luminous intensity by varying the magnitude of an electric field applied to a conductive coating on the electroluminescent layer. By this means, it is possible to produce various patterns of lines and dots, moving or stationary, stated to be of value in electronic equipment operation.

A MAMMOTH LIGHTING INSTALLATION has shortly to be provided by Westinghouse for a new sports stadium at Washington, D.C. More than 2,100 floodlighting lanterns, each rated at 1,740 W, have been used to make the stadium the best lighted outdoor sports facility in the US. The stadium is used for both baseball and football; for the former, the lighting follows the traditional American pattern of being brighter in the infield, where the illumination is 200 lm/ft² as against 150 lm/ft² in the outfield. The lighting pattern will be changed for football games to a uniform brightness over the field. The lanterns are to be mounted on eight towers sited on top of the upper deck of the stadium; the largest tower will carry 360 lanterns.

BLC Activities

The following list shows some of the lecture activities of the British Lighting Council in September.

September 5
Truro, Chamber of Trade. Shop lighting, by R. S. Hazell.
Reading, ASEE. The IES Code and commercial buildings, by A. D. Charters.

September 7
Bradford, ASEE. Industrial lighting.

September 12
Accrington, Chamber of Trade. Shop lighting, by E. P. Lee.

September 13
*Ipswich, for staffs of BLC members. Lighting promotion, by A. Wilcock.

September 14
Birmingham, Chamber of Commerce (4.30 p.m.); ECA. Aims of the BLC, by D. Whipp.

September 20
*Durham Castle. A meeting for local authorities with talk by A. Wilcock.

September 21, 25
London, Brettenham House. Conference for staffs of BLC members on office lighting.

September 25
Carshalton, Chamber of Commerce. Shop lighting, by J. F. Roper.
Caversham, ASEE. The IES Code and commercial buildings, by A. D. Charters.

An open invitation is extended to readers of LIGHT AND LIGHTING to all meetings marked with an asterisk. For invitations to other meetings, and for further details, please contact nearest BLC Regional Engineer.

Situations

Vacant

SENIOR LABORATORY ASSISTANT (preferably under 30) to be responsible for photometric and thermometric work on lighting fittings and associated problems. Work includes interesting development of techniques and apparatus allied to design of lighting fittings. Knowledge of glass, plastics, electrical circuitry and fundamental problems of vision in artificial light would be helpful. Some personal contact with clients, technical associations and manufacturers will be necessary. Company pension scheme. Salary according to ability and experience (Dip. Member of IES would be an advantage). Apply fully, marking envelope 'Confidential', to Technical Director, Holophane Ltd, Elverton Street, Westminster, SW1.

COUNTY BOROUGH OF OLDHAM
Lighting Department

TECHNICAL ASSISTANT
STREET LIGHTING

Applications are invited from suitably qualified persons for the above appointment which is superannuable.

The salary is within the grade of APT II (£815 to £960 per annum) and a five day week is in operation.

Applicants should have a sound knowledge of all aspects of lighting, particularly street lighting.

They should possess the Ordinary National Certificate in Electrical Engineering and should hold, or be studying for, the Intermediate Certificate of the City and Guilds of London Institute in Illuminating Engineering.

Some form of membership of the Association of Public Lighting Engineers will be an advantage.

Further particulars and application form can be obtained from the Superintendent, Corporation Lighting Department, Gas Street, Oldham, with whom applications, giving the names of two referees, should be lodged on or before the 11th September, 1961.

Canvassing will be a disqualification.

EDWARD HAINES,
Town Clerk.

3rd August, 1961

Postscript

ONE OF THE MOST INTERESTING series of papers to come out of the Russian lighting literature is that which appeared recently, dealing with the lighting of windowless buildings. Kroll, in the August 1960 number of *Svetotekhnika*, takes as his starting-point the need to create artificially the equivalent conditions for naturally lit rooms. This, he states, will be achieved if the apparent brightness is made the same as it would be in daylight. He makes use of Meshkov's equations for apparent brightness, which are based on the Fechner integration of just noticeable difference steps (a procedure long out of countenance in this country), and thence deduces what would be the mean apparent brightness through any given period (e.g. twenty-four hours for three-shift working) with the normal ration of daylight and artificial light. His final table of recommended illumination levels of a windowless room is derived from these calculations.

The tables indicate that levels must be higher than in interiors of the same type lit by daylight. For example, if the work demands a Daylight Factor of 10 per cent, the illumination in a windowless room should be 75 lm/ft², instead of the 50 which would otherwise be provided (presumably determined via the customary sky of 500 lm/ft²). The calculated values agree closely with those already recommended by the Russian lighting code for windowless rooms, but it is not made clear whether the code values are based on Kroll's method or whether his is an independent approach to the problem.

If I have understood him or his translator correctly, Kroll believes that the subjective values of light embraces a 'time factor, in other words, the human being has some sort of emotional storage so that the longer you expose him to light the more effect he gets from it. The ordinary windowless building fails because it does not provide the high peaks of illumination received around midday in a daylit room, the effect of which carries over into the duller periods. This is all my own guesswork, for Kroll does not say as much, but it seems necessarily inherent in his thesis. I find the idea quite original, and although I do not believe it is valid precisely in the way in which Kroll uses it, it may well spark off a train of other ideas which may help to solve the problem of the lighting of windowless buildings. Both Weston and the BRS people, with their ideas on the need to vary lighting during the working day, may find some food for thought here.

MY OBSERVATIONS ON THE SIGHTING of supernumerary rainbows have brought in a number of comments which I have read with great interest. The subject is very fully treated in *Physics of the Air* by Humphreys, published by McGraw-Hill, and also in *Light and Colour in the Open Air* by M. Minnaert, published by Dover Publications. I had no idea so much is known about the explanations in physical terms of the optical oddities of our atmosphere. The supernumerary bows are most likely to be seen when the raindrops are of a particular size, between 1 and 2 mm diameter. Their formation is due to rays of sunlight being internally reflected in the raindrops but suffering less than minimum deviation. Under such conditions interference or diffraction occurs, and it is this which causes the supernumerary bows. The answer to my query therefore seems to be first, that the supernumeraries are not always there, but only when the raindrops are of a certain size; and second, that when they are there, physically, it will depend on sky conditions, such as the brightness of the sky background, as to whether or not we can see them. These supernumeraries change very quickly in brightness and colour, because raindrops rarely remain constant in size distribution. This could well account for the fact that my colleague, who was with me when I observed the phenomena which gave rise to my comments, claimed to be able to see five bows whereas I only saw three. According to Humphreys, five bows is the maximum number, so it was just as well that my colleague did not claim to have seen six.

SOME OF MY READERS may have seen the programme on television which showed how a baby's vision develops month by month. Some ingenious experiments were shown, which demonstrated that the baby's visual acuity improves steadily from birth. It may not be the optical system of the baby's eye which is changing, however, but the intelligent interpretation of the visual images which are received. I recall some years ago Hopkinson's work on schoolchildren's vision, which led to the present Ministry of Education Regulations on lighting. He showed that young children, in the six-year-old age group, did not perform so well when reading chalkboard lettering as did older children, and suggested then that the reason was probably not due to defective optics in the younger children's vision, but simply that they had not yet the experience and intelligence to guess at the meaning of slightly blurred images, whereas the older children could make an accurate guess based on previous knowledge.

On the other hand, a child's vision can, though fortunately rarely, begin to deteriorate quite early and if this happens it is sometimes hard to detect. This has in fact happened to a small boy I know aged eight. At school he sits near to the chalkboard and has sufficient experience to guess reasonably well what the slightly blurred images mean. It was not until the school holidays began and he spent more time out of doors with his parents that the latter noticed something wrong, which was confirmed by an early visit to the optician. The small boy now wears glasses and his progress at school, which had previously been considered fairly satisfactory, has shown a marked improvement—much to his own pleasure and that of his parents who consider the regular bills for repairs to spectacles to be a small price to pay for their son's increased interest in the things around him.

THERE HAVE BEEN SEVERAL DEMONSTRATIONS recently of the new iodine-cycle filament lamps, which are claimed to have almost limitless life together with negligible drop in light output. I believe it was Dr Strange who some years ago said that if the fluorescent lamp had come first, the invention of the filament lamp would have been hailed as a major discovery with its advantages of compact size and no need of any ballast. If indeed we are to have a filament lamp with all the advantages of the fluorescent lamp and none of its disadvantages, will that mean the disappearance of the fluorescent lamp during the course of the next few years? And if it does go, will there be a Betjeman to mourn its passing, and will *Fanny by Fluorescence* be a best-seller of 1984?

'Lumeritas'

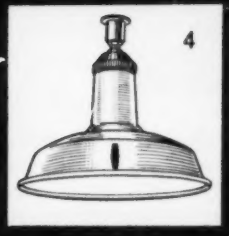
If it's a question of lighting . . . leave it to Simplex

Notice we say lighting — not lighting fittings. We supply the right lighting equipment for a diversity of industrial applications. But, you are interested in the end, not the means. You want the right amount of light in the right place at the right time. And once the job is done you want to forget it.

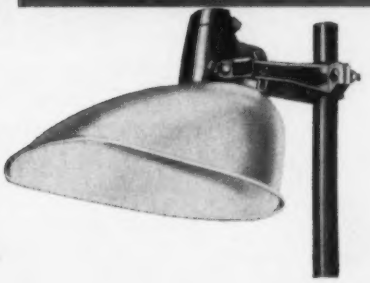
So like so many people nowadays, you call in Simplex first. After all, it's only common sense to ask the experts in industrial lighting how your objective can best be achieved, which type of light fittings are ideal for the job, how many you need, where they should be located. There is no obligation of course.

Here's what to do: Reach for your telephone book. Look up your local Simplex branch. Ask them to send someone round for an informal discussion.

1 Simplex Blended High-Bay Fitting
2 Simplex Fiesta-Flood
3 Simplex Wall Bracket Screwglass Fitting
4 Simplex Dispersive Reflector
5 Simplex ACF (Anti-corrosion Fluorescent) Fitting



SIMPLEX DISCON an easy disconnection device fitted as an alternative standard item on all Simplex Dispersive, Parabolic Angle and Display reflectors. It enables the fittings to be easily disconnected from the conduit system for maintenance and also provides for the interchange of lighting fittings after installation. Suitable for fittings carrying lamps up to 1,500 watts G.L.S. or 1 kW. M.B.F./U.

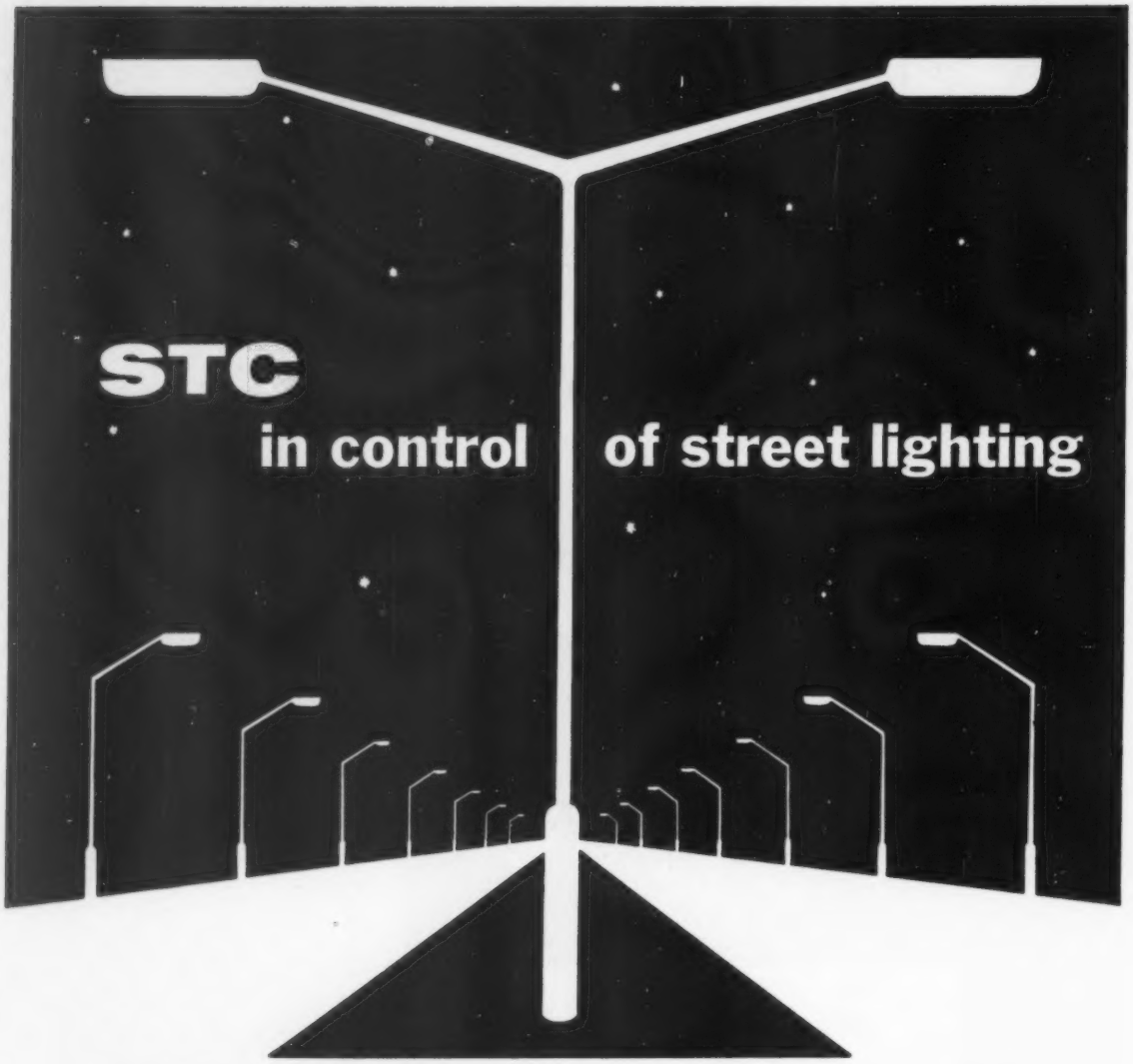


Simplex

SIMPLEX ELECTRIC COMPANY LIMITED
CREDA WORKS, BLYTHE BRIDGE, STOKE-ON-TRENT, STAFFS.
Branches throughout Great Britain and Agents throughout the World

Detailed literature available on request

ELECTRICAL DIVISION L.11



STC

D.C. BIAS CONTROL SYSTEMS

Lighting-up time presents no worries to progressive city and town authorities who have entrusted their street lighting and "off-peak" load control to the STC D.C. Bias System. Simple and completely reliable, the D.C. Bias System is inexpensive, easy to install and maintain and can be readily expanded to meet extensions in street lighting networks. Furthermore, the operating impulse cannot intrude into neighbouring areas. These are only some of the advantages of the STC D.C. Bias System. You can examine the technique in detail, without obligation, by consulting STC. The first move is to ask for brochure D/RC6.

INDUSTRIAL ELECTRONICS GROUP

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Standard Telephones and Cables Limited

INSTRUMENTATION AND CONTROL DIVISION

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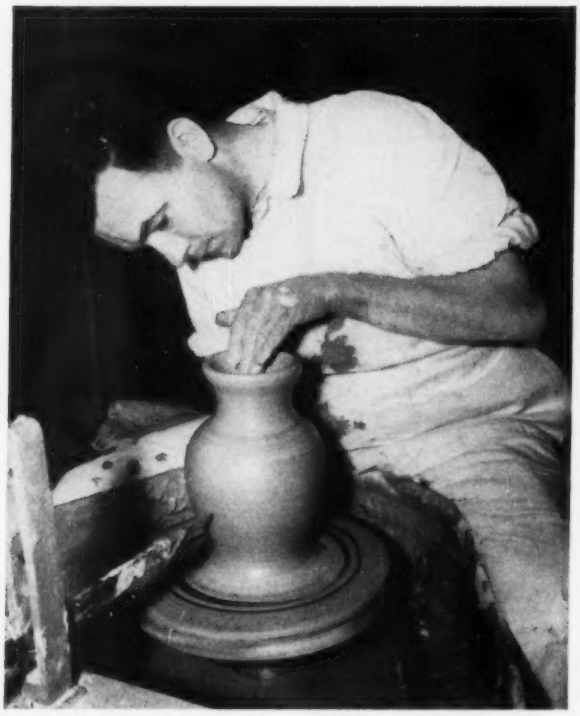

Quality in Craftsmanship, Potter (Photo Fox Photos Ltd)

CRYSELCO

lamps and fittings can be obtained from any of fourteen branches and depots throughout the country.

All CRYSELCO business is based upon a policy of Quality and Service.

This attention to detail in production and distribution, coupled with more than 60 years' experience in lamp manufacture, ensures quality products, promptly delivered.

The range of lamps and fittings available is extensive. If you have not received the current catalogue, please send for one today.

QUALITY and SERVICE

CRYSELCO BRANCHES

are situated throughout the country.

Their aim is to give you quality products plus good service.

CRYSELCO Managers in the following towns and cities would be pleased to hear from you.

BEDFORD
BIRMINGHAM
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LEICESTER
LIVERPOOL
LONDON
MANCHESTER
NEWCASTLE
NOTTINGHAM
SOUTHAMPTON

CRYSELCO LIMITED

KEMPSTON WORKS BEDFORD

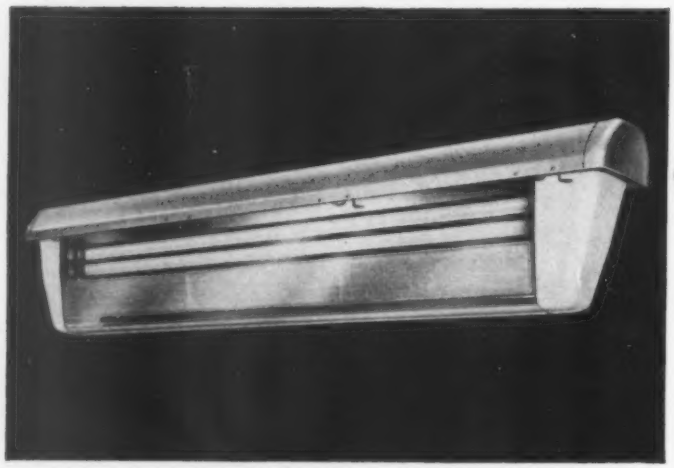
Service by Bearer, Nigeria (Photo J. Allan Cash)

G.E.C. THREE-EIGHTY LANTERN

specially designed for main road lighting

Slim and highly efficient, this is the lantern for main roads, civic and shopping centres, promenades and wherever good lighting and good looks are essential. The G.E.C. "Three-Eighty" Lantern is non-corrodible, is made of lightweight alloy extrusion, and castings and the "Perspex" refractor plates are bonded to the inside of the "Perspex" bowl. The lighting is by three 80 w. 5 ft. Osram guaranteed fluorescent tubes operated by G.E.C. trouble-free, quality control gear.

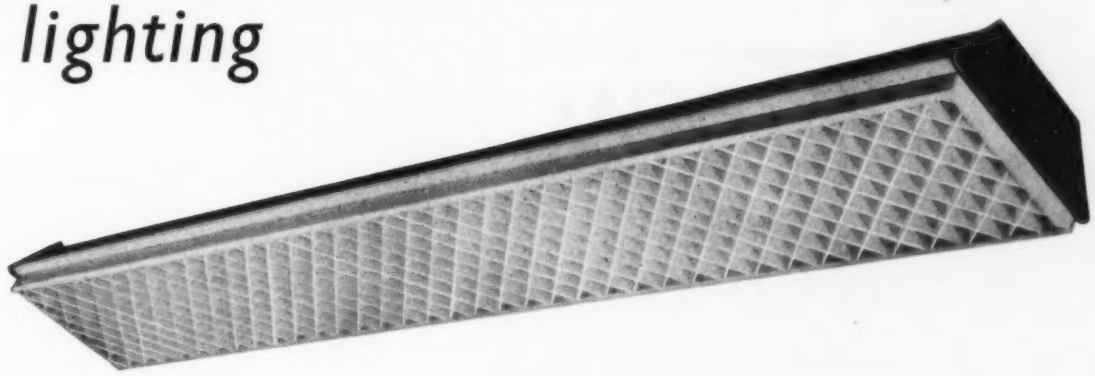
Send for full details or, better still, let Britain's leading lighting designers work with you right from the initial planning stage to the "switch on".



G.E.C.
LIGHTING DIVISION

The General Electric Co. Ltd., Magnet House, Kingsway, London, WC2

plastic components in lighting



1 Complete light diffuser fabricated from moulded and extruded plastics. Produced for A.E.I. Lamp & Lighting Co Ltd.

2 'Elcoplas' louvre ½" mesh x ½" depth, Diamond or Square Mesh. Registered Design No. 873594.

3 'Elcoplas' louvre 1$\frac{3}{16}$" mesh x 1" depth, Diamond or Square Mesh.

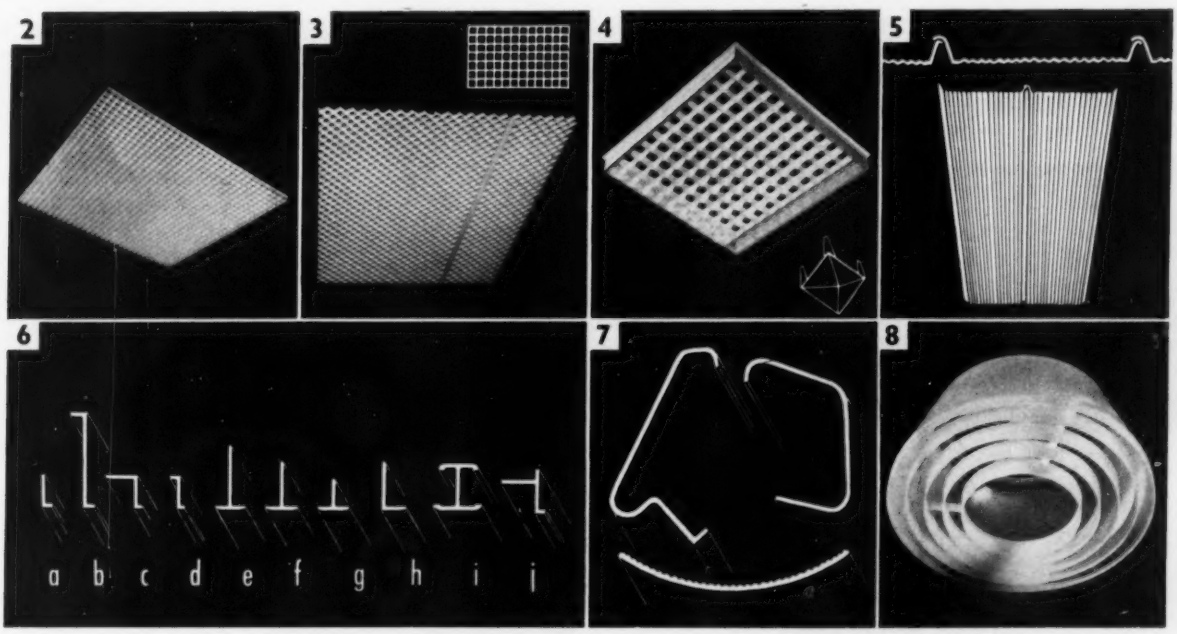
4 'Elcoplas' modulus louvre 2" mesh x 1¾" depth, Diamond or Square Mesh, illustrated with plastic 'Z' framing. Coloured Pyramids in five different colours available for fitting into the cells.

5 'Plasmatic' diffuser panels available in opal, pearl, clear. Interlocking panels are 10½" centre to centre, and are supplied in maximum lengths of 4 ft, or less to order.

6 Plastic supporting sections.

7 Typical sections of plastic extruded diffusers, as supplied to lighting fitting manufacturers.

8 Moulded plastic shade and louvre as produced to the design of Messrs Hume Atkins & Co. Ltd. (Registered Design No. 880153).



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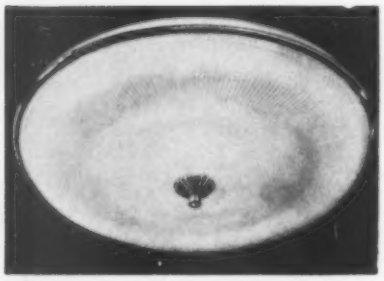

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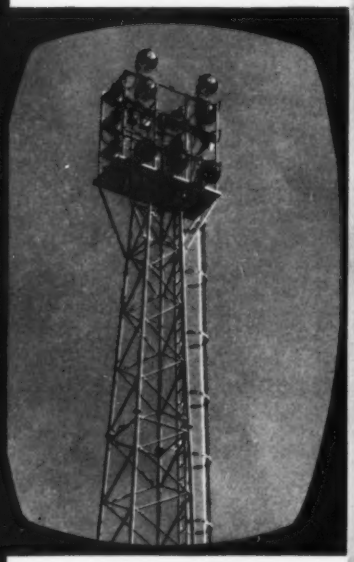
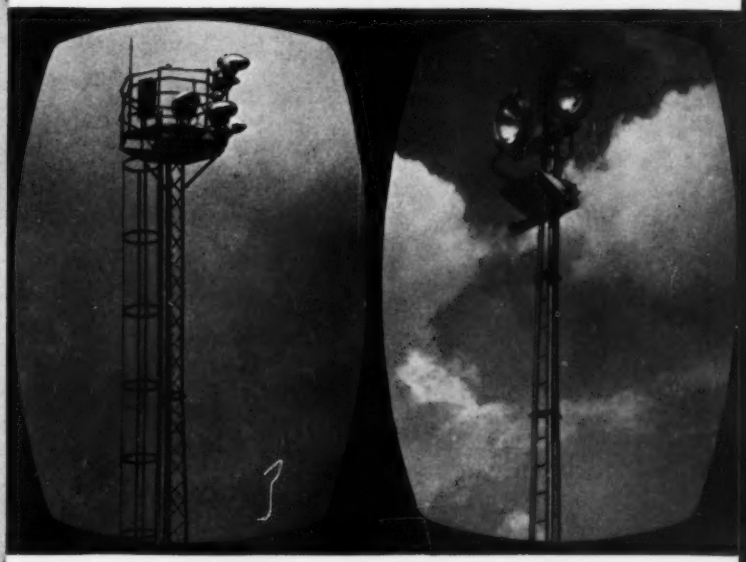


150 ft. standard Floodlighting Tower, type 150/75, for the N.C.B.

Floodlighting Tower, Chelsea Football Ground. This tower, one of six, is 107 ft. 6 in. high and mounts 54 floodlights.



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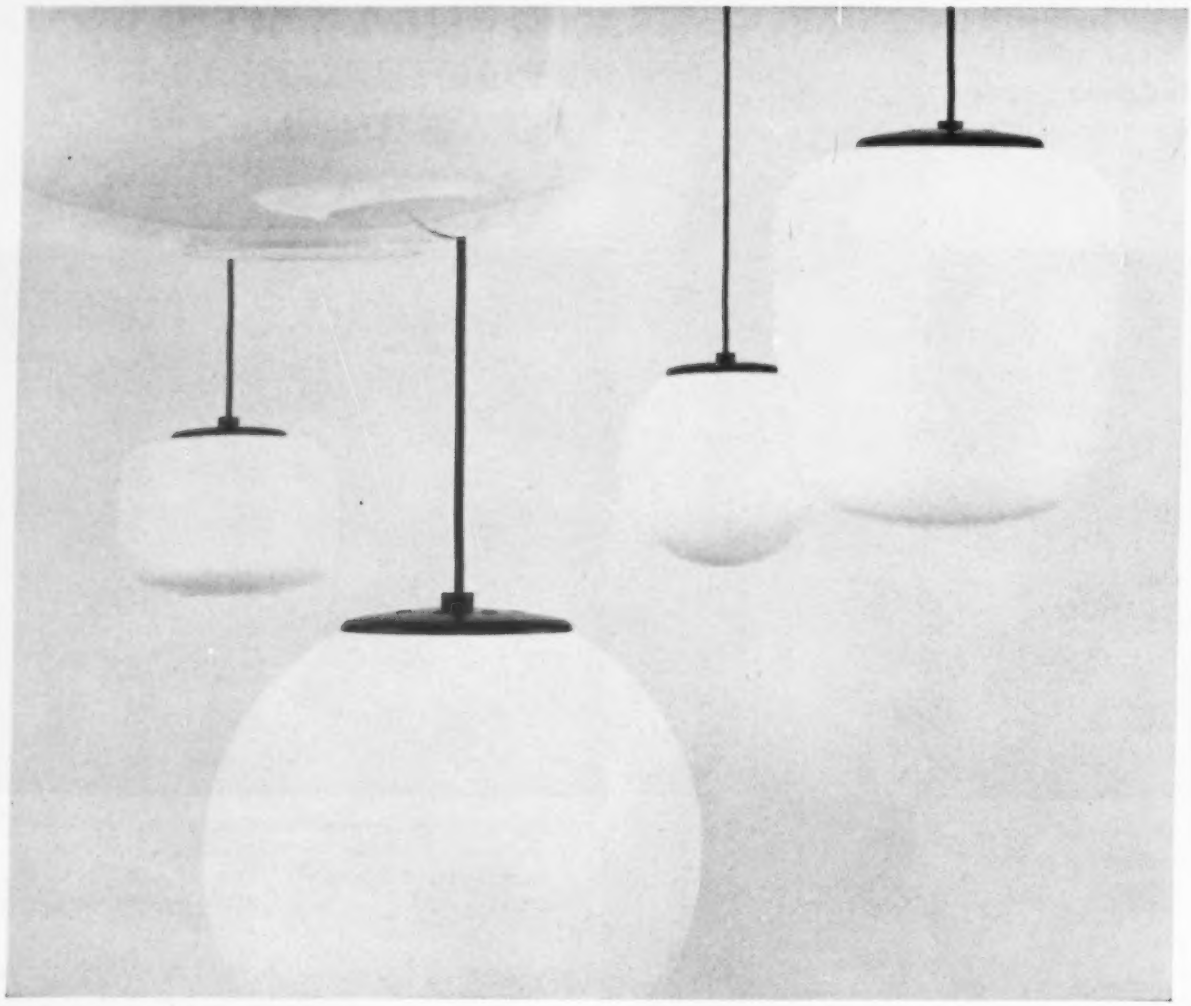

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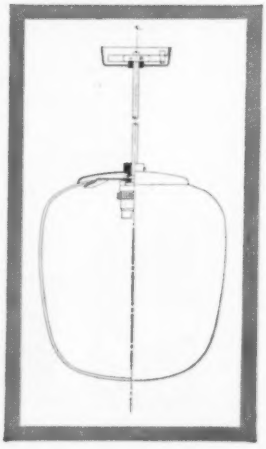

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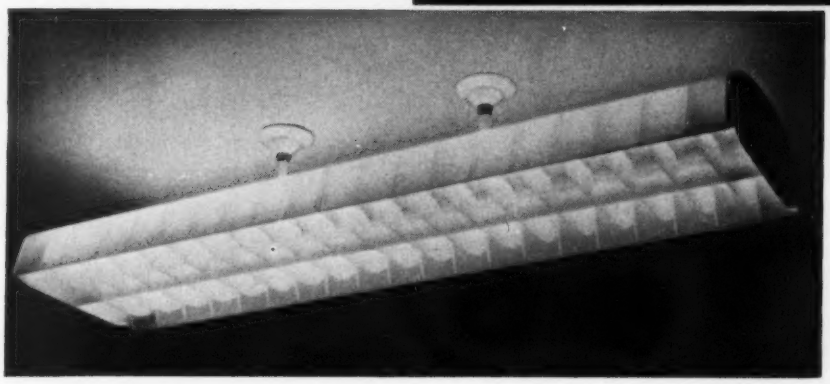

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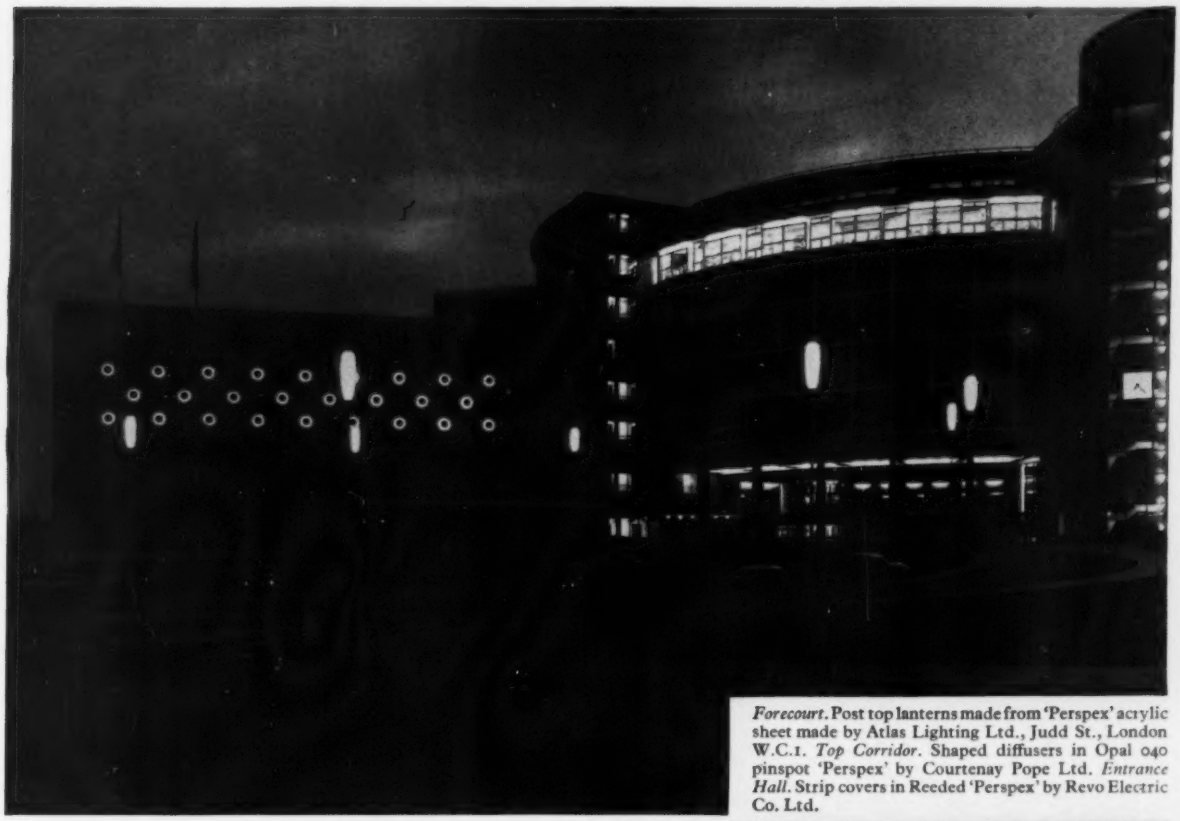

Forecourt. Post top lanterns made from 'Perspex' acrylic sheet made by Atlas Lighting Ltd., Judd St., London W.C.1. *Top Corridor.* Shaped diffusers in Opal 040 pinspot 'Perspex' by Courtenay Pope Ltd. *Entrance Hall.* Strip covers in Reeded 'Perspex' by Revo Electric Co. Ltd.

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These photographs were taken at the B.B.C. Television Centre, Wood Lane, London W.12. Architects: Graham Dawbarn, Esq., C.B.E., Norman & Dawbarn in association with M. T. Tudsbery, Esq., C.B.E., Consulting Civil Engineer to B.B.C.

FP77

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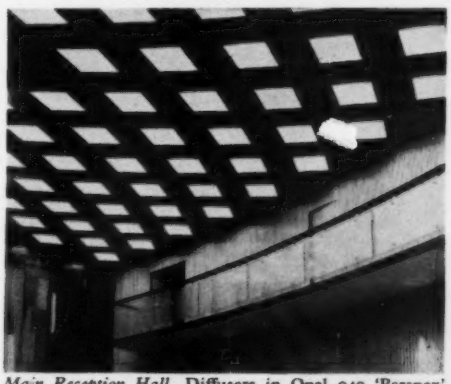
Corridors. Diffusers of Opal pinspot 'Perspex' acrylic sheet on lighting fittings made by Arrow Plastics Ltd. *Studio Doors.* 'Perspex' faced internally illuminated signs above 'Darvic' p.v.c. panels on the studio doors.



Main Reception Hall. Diffusers in Opal 040 'Perspex' acrylic sheet on ceiling lighting fittings made by Messrs. Revo Electric Co. Ltd., Tipton, Staffs.

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